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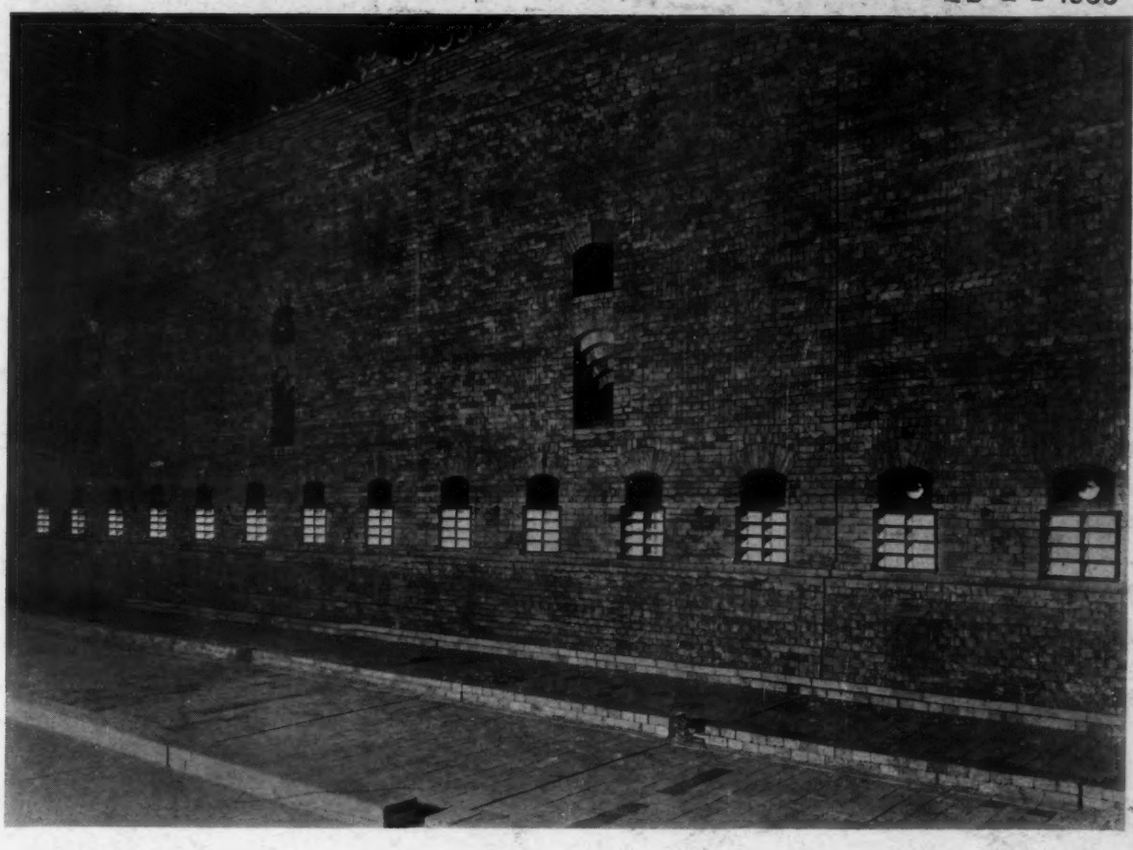

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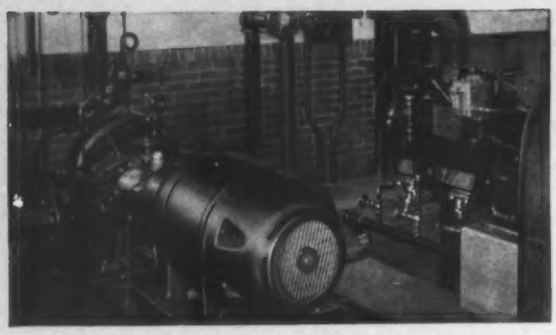
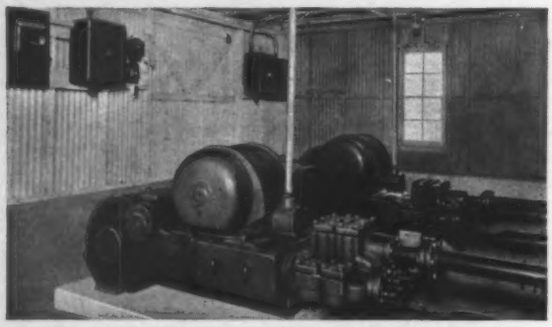
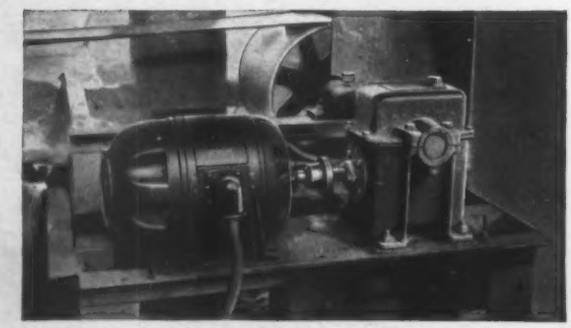


G-E explosion-proof motor driving centrifugal gasoline pump

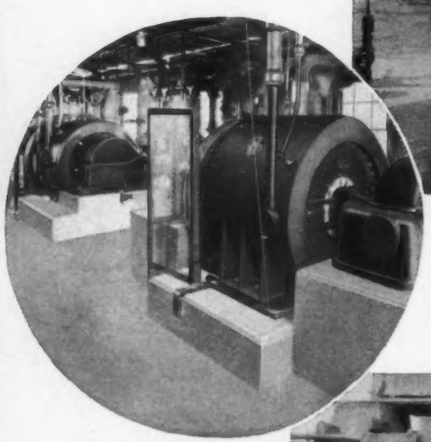


Two G-E splash-proof motors driving gathering pumps

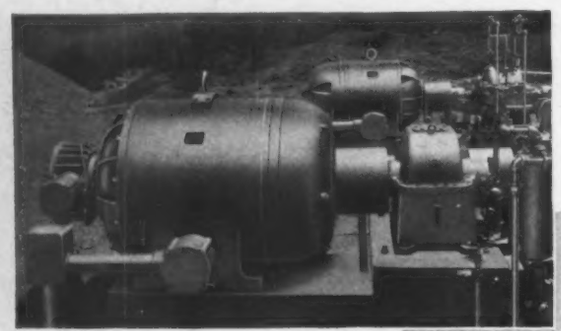


G-E totally enclosed, fan-cooled, squirrel-cage motor driving conveyor under fuller's earth burner

Outdoor installation, G-E explosion-proof motor driving oil-well pumping unit

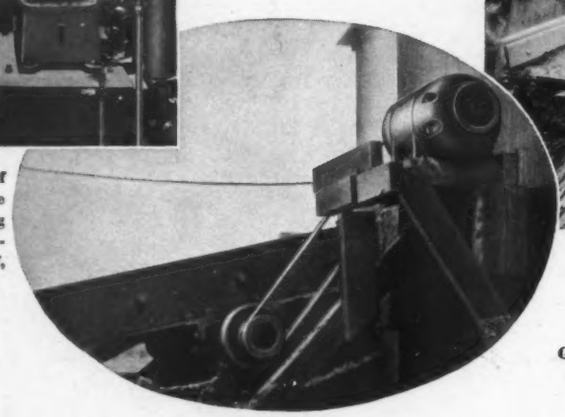


Two G-E totally enclosed, fan-cooled, inert-gas-filled synchronous motors in casing-head-gas gathering plant



Foreground, G-E 100-hp. synchronous motor of Class I, Group D, construction driving gasoline and reflux pumps through G-E speed-increasing gear; background, standby unit with G-E 75-hp. totally enclosed, fan-cooled, explosion-proof, squirrel-cage motor. Outdoor installation.

G-E single-phase explosion-proof motor driving mud screen, outdoors



G-E totally enclosed, fan-cooled, squirrel-cage motor driving mud screen, outdoors

G-E explosion-proof motors are tested and listed by the Underwriters' Laboratories for service in hazardous gas locations defined as Class I, Group D, by the National Electrical Code

200-614

GENERAL ELECTRIC

REFINER
AND NATURAL GASOLINE MANUFACTURER

FEBRUARY, 1933
Vol. 12, No. 2

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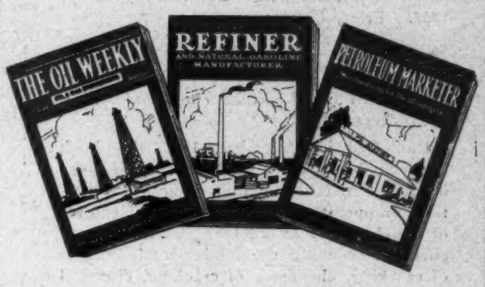

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VOLUME 12, No. 2 FEBRUARY, 1933

Industry Must Right Itself

FOR more than three years industry has been waiting. It has been lulled by the hope that strength sufficient to permit each unit of business to resume its normal activity, would come suddenly out of the clouds. That hope had its roots in the false impression that industry had its strength sapped by forces beyond its control, consequently it should regain strength by outside infusion.

Business should now realize that it lies prostrate because something happened to it—something it caused to happen to itself. Industry is the victim of its own sins. Fundamentally business is not different from the vision of men. Men went to the polls last November and expected a miraculous business change to follow the casting of their ballots. Since then they have been waiting for March 4 to bring this change.

Business did not strike its sour note by casting ballots or by the inauguration of any official. Neither will it strike a tone of sweetness by such.

Oil offers a good example of the waiting attitude of business. What has taken place in the last three years is evidence that the men of oil are under the impression that the petroleum industry as now constituted is essential to the world. Men seem convinced that each corporation, each refinery and each service station has an assured place in this industry.

If men do not know, they should learn that no business comes into existence stamped with an assurance of existence. There is a touch of the admirable in this holding to an ideal that all must remain. The attitude may be admirable but it is false.

Survival of the fittest is not a thing of beauty still it is a thing of truth. The oil industry like other industries must in time reestablish itself by a clash under the regulations of that law. The pondering of a seer is not required for reaching the conclusion that the United States has no need for the more than 300,000 places to buy gasoline which now exist. Neither is there need for all the refining capacity that turns out gasoline.

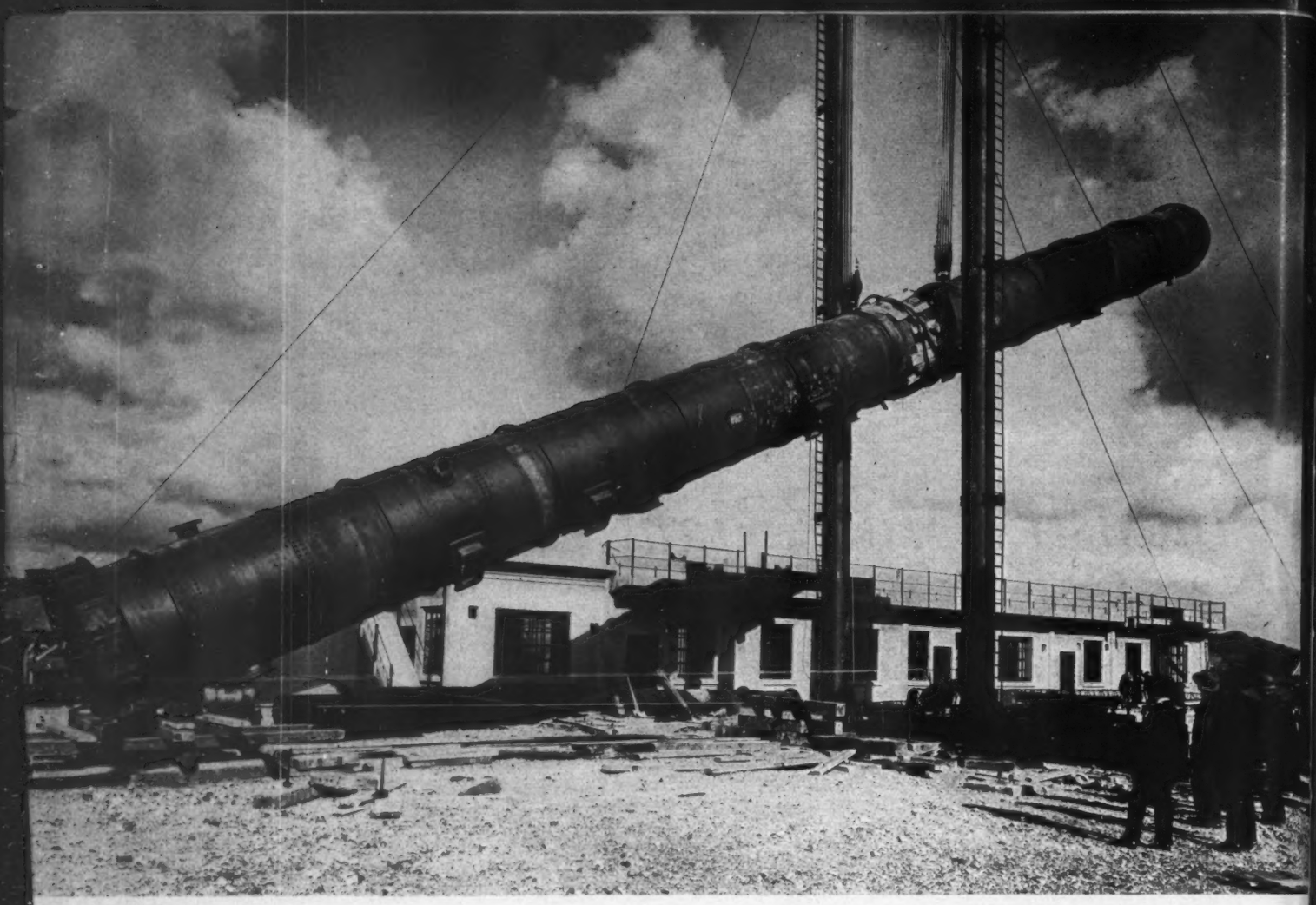
A part of these facilities came into existence in defiance of need, consequently the tag of assured life is not evident. What is assured is that the unnecessary must be discarded.

No man can select the unnecessary. Each management contends that its facilities are necessary. Each has seemed to want the other to continue to exist. Meanwhile recovery has not arrived from the ether and too little has been done to bring recovery by exercise of power still within itself.

It looks from this point like a final battle with adequate cash reserves and sound management the two banners. Since the cash reserve results from sound management, this should be the banner. To see the unfit ground out of industry is not beautiful. Unfortunately, worthy men and honest ventures get caught in the workings of survival of the fittest.

But industry has in three years found no other way. In time it must resort to what men often call the law of the jungle. There is enough gasoline being sold today to bring profit to substantial investment. It is not sufficient to bring profit to all the capital now invested in oil.

If industry, legislation and even the desires of men can not assure profit, they can not assure existence.



Hoisting vacuum tower for one of the two-stage crude oil units

Modern Refining Facilities

Provided for Operation of New French Refinery

ONE of the interesting refinery projects nearing completion in France is that of the Raffineries de la Vacuum Oil Company, S. A. F. This refinery, like the others now being constructed in France, is being built as the result of legislation passed during the past few years placing a time limit on the duration of existing licenses for importing finished petroleum products into France as well as placing a substantial duty protection on products manufactured in France. This legislation makes it necessary for the petroleum distributing companies doing business in France to manufacture on French territory.

The Vacuum Oil Company refinery is being built on the lower Seine River at Port Jerome, where the Port of Rouen is constructing a petroleum basin for the receipt of crude oil and the shipment of inflammable finished products. This location is favorable for the receipt of crude oils from abroad, there being practically no crude oil production in France, and for distribution to the principal industrial area of France, which is located adjacent to the Seine Valley.

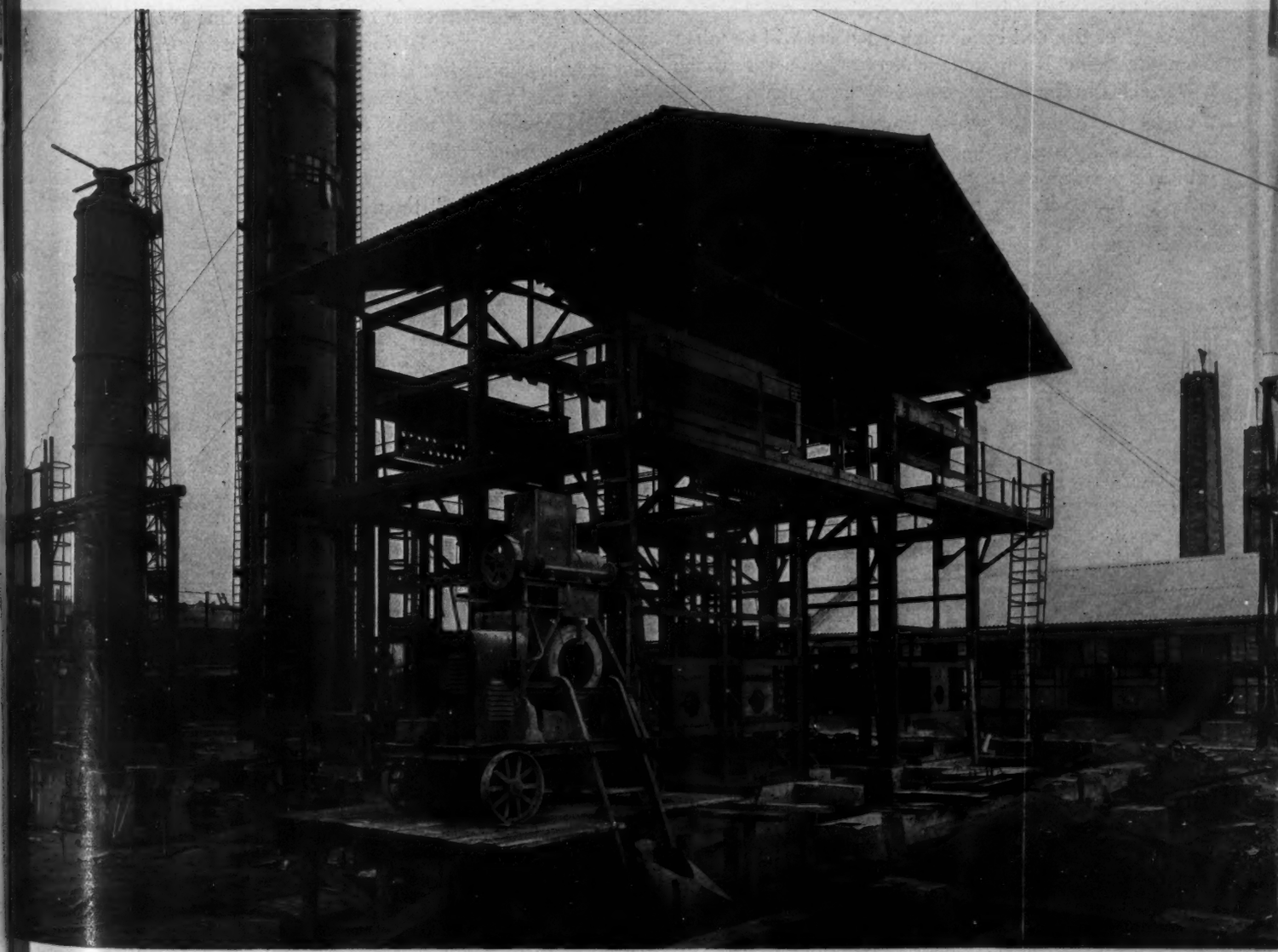
This refinery is designed as a complete lubricating plant and will run on selected crudes to produce the lubricating oils which are marketed by this company in France. The refinery will occupy an area of approximately 150 acres, and will have an approximate daily capacity of 5000 barrels.

The principal distillation units will be two two-stage atmospheric and vacuum pipe stills, particularly designed to handle the crudes which will be run. In addition, there will be two pipe stills for re-running operations. There will also be installed a three-furnace cracking still, equipped with a viscosity breaker and a naphtha reforming unit. The pressure distillate from this

General view of the Power Plant

—Pictures courtesy Foster Wheeler Corporation.

Close-up of the two rerun units showing fractionating columns and tubular oil heaters under construction



plant will be passed through a continuous Sharples centrifuging treating plant and will be re-distilled by waste heat from the cracking plant. The cracking plant is designed to handle gas oil, crude oil and surplus distillates from the crude units. The wax distillate from the crude units will be dewaxed in a more or less conventional wax plant, the refrigeration to be supplied by compression machines. The bright stock will be dewaxed in a Sharples dewaxing plant.

Steam and electricity will be supplied to the refinery from a power plant located near the river. The boilers will be operated at 350 pounds pressure. The boilers are especially designed to burn acid sludge fuels from treating departments. The steam from the boilers at 350 pounds will be passed through a back-pressure turbine exhausting at 150 pounds. The general refinery steam will be distributed at this pressure. A second back-pressure turbine will also take steam at this pressure and exhaust at 25 pounds, which steam will be distributed to the refinery for general heating service. A third turbo-generator will be a condensing unit taking steam directly from the boilers at 350 pounds. This unit will be used to balance steam demands, only making the amount of electricity required beyond that produced by the back-pressure turbines.

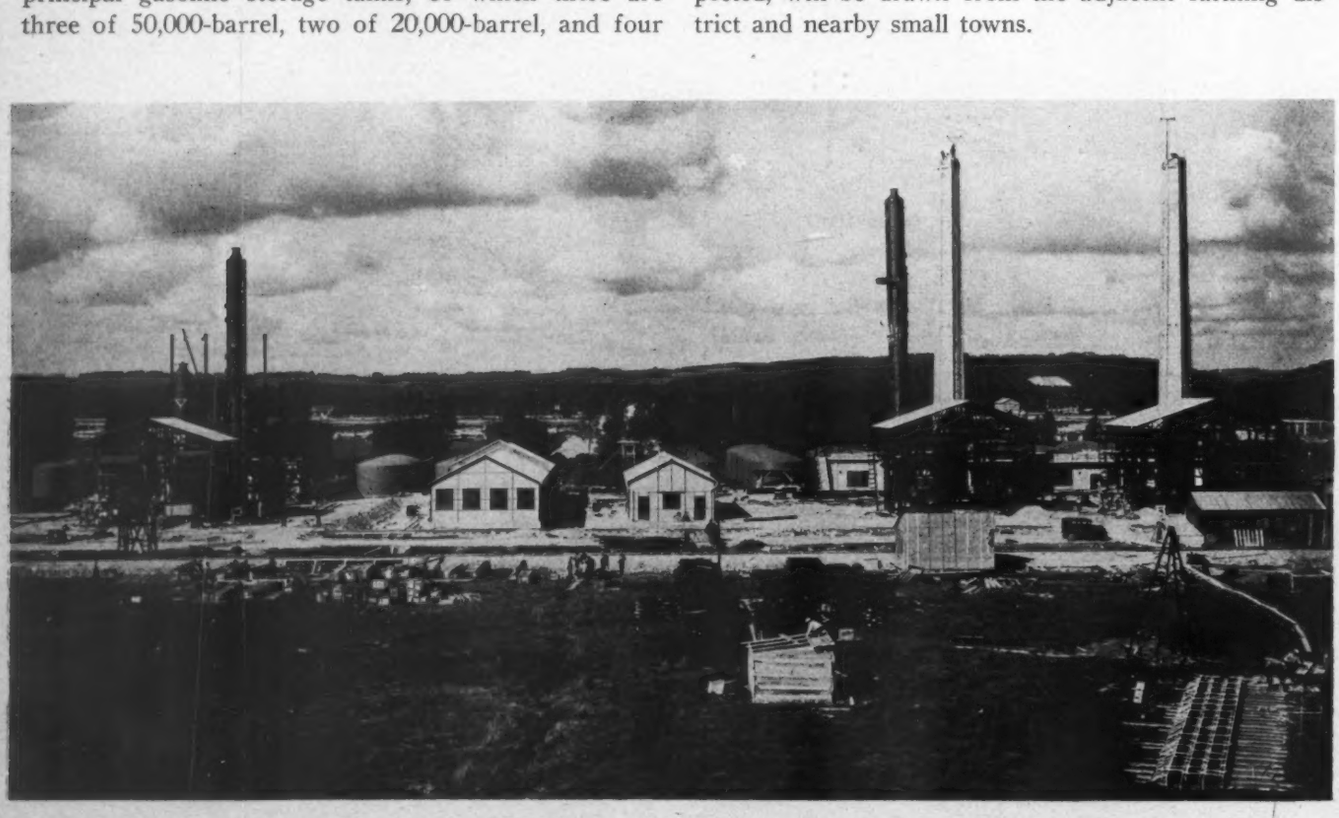
Water for fire and condensing purposes will be taken from the Seine River and delivered by pumps in the power plant to the desired points in the refinery.

Crude oil tanks, of which there are six of 80,000-barrel capacity, are equipped with breather roofs. The principal gasoline storage tanks, of which there are three of 50,000-barrel, two of 20,000-barrel, and four of 10,000-barrel capacity, will be equipped with floating roofs to reduce evaporation losses.

Finished lubricating stocks will be delivered from the contact-filter plant to the compounding and shipping department, from which shipments will be made to all parts of France in barrels and to the existing Rouen can filling plant by barge.

While most of the departments of this refinery are of American design about 95 per cent of all of the equipment installed is of French manufacture. This is due to the specific requirement of the French government in granting licenses for the construction of refineries that all material and equipment used in their construction must be of French manufacture unless it could be proved that such articles could not be made in France.

Under construction, in addition to the refinery, is practically a complete village for important employes. The program calls for the construction of housing for 100 families, in addition to 10 houses for the superintendent, engineers, chemists, etc. This construction has been found necessary, first, because the location of the refinery is from 10 to 20 miles from the nearer towns, which are small country villages, and, secondly, because the French workman in general does not own his own home and is accustomed to having his housing provided for him when he works for a large industry, even in the neighborhood of the larger cities. It is expected that the total number of employes will be 400, but only the men from the principal departments will be housed in the workmen's village. The other employes, it is expected, will be drawn from the adjacent farming district and nearby small towns.



General view of Raffineries de la Vacuum Oil Company, S. A. F. Port Jerome, France, Showing the two rerun units at left, and the two-stage crude units at right

Heat Flow Diagram of a Two-Stage Distilling Plant

G. VANDENBERG
Mechanical Engineer

IN a well balanced process, the following heat flow formula is used in exacting the physical state for the whole process as well as for a part of it.

This is shown graphically in Figure 1 for an element of the process, and is shown in a diagram (Figure 2) for the whole process.

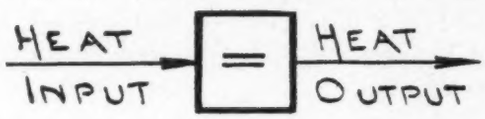


FIGURE 1

Energy can not be destroyed, only its form can be altered. On this principle is formula (1) based, which is the foundation for every heat balance. For instance: the number of Btu's generated in the fire box under the boiler, is equal to the number of Btu's absorbed in steam plus the number of Btu's leaving in flue gases.

The distillation of hydrocarbons is analogous to steam generation in a steam boiler plus the ensuing condensation, although it happens between the Btu's liberated in the furnace and those carried off in the water, as an intermediate process of heating, vaporization, separation, condensation and cooling and is in itself a closed cycle, when we assume that oil and distillation products enter and leave at the same temperature, say 60°F and the process proceeds without considerable losses. This assumption is approached with cooling water leaving at 61°F and distillate at 62°F. The amount of heat carried off by the distillation products, in this 2°F difference, is negligible.

These statements are written in the following formula:

$$\text{Heat generated in furnace} = \left\{\begin{matrix}\text{Heat absorbed by}\\ \text{distillation}\\ \text{plus}\\ \text{Heat in fluegases}\end{matrix}\right\} = \left\{\begin{matrix}\text{Heat carried off}\\ \text{in cooling water}\\ \text{plus}\\ \text{Heat in fluegases}\end{matrix}\right\} \quad (2)$$

This equation expresses that the heat taken up by the distillation cycle is passed on to the cooling water, granted of course that the process occurs without losses. Formula (2) can be narrowed to:

$$\text{Heat generated in furnace} = \left\{\begin{matrix}\text{Heat carried off}\\ \text{in cooling water}\\ \text{plus}\\ \text{Heat in fluegases}\end{matrix}\right\} \quad (3)$$

Looking at diagram Figure 2, it is seen that Form 3 can be written in the following form:

$$F_1 + F_2 = S_1 + S_2 + W_1 + W_2 \quad (4)$$

or, if the heat of the incoming steam is included:

$$F_1 + F_2 + \text{steam} = S_1 + S_2 + W_1 + W_2 \quad (5)$$

A simple conclusion, that may be drawn from these formulas is, that the less cooling water the installation requires, the less fuel will be consumed. Naturally, the less fuel is burned, the less Btu's escape through the smokestack, the higher the overall efficiency and the more economical the installation operates. In other words, the more the heat is turned back into the process through application of heat exchangers, the less fuel and the less cooling water will be necessary, effecting a saving in fuel, in water, and investment.

The heat flow diagram is used here to bring out these characteristics and is applied to a two-stage distilling plant. Although the added flash tower, which takes off cylinder stock overhead, tends to make it a three-stage plant. A few calculations for a throughput of 15,000 barrels per day will be introduced here in order to show how the different figures for the construction of the heat flow diagram are obtained.

The quantities of Btu's involved, are calculated according to Publication No. 97 of the Bureau of Standards, titled "Thermal Properties of Petroleum Products.*

*Elsewhere in this issue and published in connection with an article, "The Utility of Graphical Charts in Design and Operation" by C. M. Johnson, Tables 12, 15, 16, and 17 upon which the present writings are based, are presented in graphical form, both on rectangular ordinates and as alignment charts. The book can be procured from the Superintendent of Documents, Washington, D. C., and costs 15 cents. The tables are comprehensive and comprise all necessary data.

ATMOSPHERIC PIPE STILL

(All Calculations Above 60°F.)

Entering the heating coils: 15,000 barrels per day; 375° A.P.I.; 300°F entrance temperature; 1 gallon = 6.972 lbs.; 26,250 gallons per hour; 183,015 lbs. per hour.

The entering charge is preheated in exchangers up to 300°F. It is assumed that 50 per cent will be vaporized and 50 per cent will remain in the liquid state and that the outlet temperature will be 550°F. Furthermore 2000 pounds of low pressure steam will be superheated to 900°F in a coil, specially built in for this purpose.

The heat added in the Pipe Still, consists of: 183,015 pounds absorbing sensible heat from 300°F to 550°F. Spec. heat at 550° = 694 (Table 12)

Spec. heat at 300° = $\frac{.571}{1.265}$

Average spec. heat .632 Btu/°F/lbs. 183,015 × (550-300) × .632 =	28,916,370 Btu
$\frac{183,015}{2}$ = 91,508 lbs. absorbing latent heat of evaporation a ca 80 Btu/lbs. (Table 15) 91.508 × 80 Btu =	7,320,640 Btu
2000 pounds steam, heated from 250°F to 900°F, spec. heat .55 2000 × (900-250) × .55 =	715,000 Btu
Fuel will be dry gas of 1600 Btu per cubic foot. Total amount to be burned about 30,000 cubic feet per hour. Total heat liberated: 30,000 × 1600 =	48,000,000 Btu
In flue gases	11,047,990 Btu

In: 48,000,000 Btu = out: 48,000,000 Btu

Efficiency of furnace: $\frac{(48,000,000 - 11,047,990)}{48,000,000} = .77$

The above mentioned amount of sensible heat: 28,916,370 Btu represents only the added sensible heat. The total sensible heat of the oil, above 60°F, includes:	
183,015 × $\frac{.571 + .453}{2}$ × (300-60) =	22,532,500 Btu
.571 and .453 being the spec. heat at 300 and 60. Amount of heat flowing from the Pipe Still to the fractionator:	
Sensible heat at 300°F	22,532,500 Btu
Added sensible heat (to 550°F)	28,916,370 Btu
Latent heat of vaporization	7,320,640 Btu
In steam (above 60°) 2000 lbs.	2,260,000 Btu
In steam superheat	715,000 Btu
Total	61,744,510 Btu

ATMOSPHERIC FRACTIONATOR

The amount of heat entering in hot oil, vapors and steam	61,744,510 Btu
The amount of heat leaving:	
30% Gasoline overhead ....240°F	10,385,000 Btu
Steam overhead 2000 lbs....240°F	2,254,000 Btu
7% Naphtha, side stream....300°F	1,510,425 Btu
10% Kerosene, side stream....360°F	2,848,125 Btu
3% Gas oil, side stream....425°F	1,159,200 Btu
50% Hot bottoms at ....500°F	21,907,510 Btu
Amount to be dissipated by reflux..	21,907,510 Btu

In: 61,744,510 Btu = Out: 61,744,510 Btu

The amount of heat to be dissipated by reflux is taken up by the evaporation of reflux from 60°F. to vapor of 240°F. One gallon requires about 1320 Btu and the total amount of reflux, to be pumped to the tower:

$\frac{21,907,510}{1,320}$ = 16,957 gallon per hour = 283 g.p.m.

The heat contents are calculated according to tables 12, 15, 16 and 17 of the above mentioned bulletin. We wish to point to the statement: "it has been found that many of these (the thermodynamic) properties are very closely related to the density of the liquid" and where the conditions frequently change, it must be understood that the calculations represent average conditions for average gravities and average temperatures. A heat balance for a refining process must be an approximation, due to variation in density and composition.

By calculation it is found that the gravity of the bottoms of the Atmospheric fractionator to be about 24° A.P.I. and it is assumed that this oil, without loss of temperature, is transferred to the vacuum pipe still.

VACUUM PIPE STILL

The oil enters the coil at 500°F and leaves at 760°F., mixed with 2000 pounds of superheated steam. Sensible heat of oil at 760°F		21,680,250 Btu
Steam (above 60°F), 2000 pounds		2,260,000 Btu
Leaving:		
Oil vapors at ....760°F		42,783,330 Btu
Superheated steam at ....760°F		2,877,000 Btu
In flue gases		7,079,920 Btu
Heat produced in furnace:		
18,000 cu. ft. a 1600 Btu/cu. ft. =		28,800,000 Btu

In: 45,604,330 Btu = Out: 45,604,330 Btu

Efficiency of furnace: $\frac{(28,800,000 - 7,079,920)}{28,800,000} = .75$

VACUUM FRACTIONATOR

Incoming heat consists of:		
91,508 pounds hydrocarbon vapors mixed with 2000 pounds of steam at a temperature of 760°F		45,604,330 Btu
Out-going heat consists of:		
6% Gas oil overhead at....400°F		3,130,250 Btu
2000 pounds steam overhead...400°F		2,480,000 Btu
22% P. wax, side stream....430°F		8,898,123 Btu
4% UP wax, side stream....540°F		2,225,280 Btu
8% Cyl. stock, side stream....650°F		4,979,800 Btu
9% Bottoms ....700°F		6,678,238 Btu
Dissipated by reflux		17,212,639 Btu
1% Unaccounted for.		

In: 45,604,330 Btu = Out: 45,604,330 Btu

Amount of reflux to be pumped back to vacuum fractionator:

$\frac{17,212,639}{1,989}$ = 8,674 gallons per hour = 145 g.p.m.

FLASHING TOWER

The procedure of flashing is dividing or breaking up the incoming stream by means of spraying or otherwise, into small particles or drops, thus increasing the surface of evaporation and facilitating the dissociation of the lighter fractions. Danforth, in his article on the "Effect of Vacuum on Lubricating Oil Distillation" in the Refiner of July, 1932, says, "If

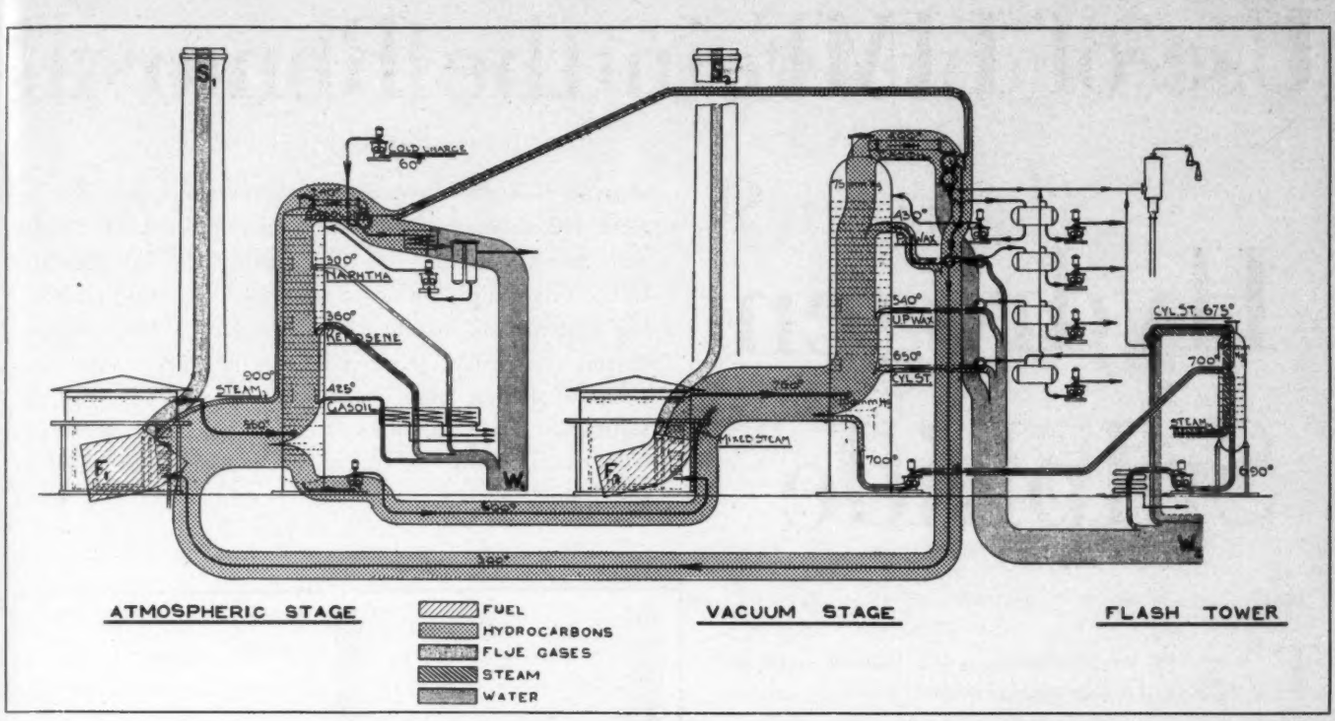


FIGURE 2

the liquid is under a hydrostatic head the low pressure will not be effective, so the main essential is to properly expose the liquid."

Vacuum evaporation is materially surface evaporation, very little evaporation taking place in the lower layers. Therefore the evaporation surface must be increased by breaking up the in-coming stream in small particles.

The pressure of 65 mm, on top of the flash column is considerable lower than the 100 mm. in the bottom of the vacuum fractionator; a difference of 35 per cent. This lower pressure and the increased exposure produce a more economical evaporation, than does the admission of large quantities of stripping steam. For this reason no stripping steam is included in this calculation, although provision for it is made.

The amount of heat entering the Flashing Tower consists of 9 per cent bottoms from the vacuum tower at 700°F and ca 15° A.P.I., totaling 6,678,238 Btu (see vacuum tower). Of this, 2 per cent leaves overhead as cylinder stock and 7 per cent as bottoms or flux oil.

And the heat balance:

Entering: 9% at 700°F..	6,678,238 Btu
Leaving: 2% at 675°F..	1,573,090 Btu
7% at 690°F..	5,105,148 Btu
In 6,678,238 Btu = out	6,678,238 Btu

With this, the calculations are completed, as far as needed for the Heat Flow Diagram. A discussion about certain assumptions may be of interest. For instance, it was assumed that all the material, when it left the vacuum pipe still, was vaporized.

There are several reasons for assuming this one being that it would not rise above its entrance at the bottom of the fractionator if it was a liquid. Another is that the latent heat of vaporization of heavy oils at high temperatures is very low, somewhere around 45 to 50 Btu per pound, whereas the sensible heat is from 400 to 450 Btu per pound, at temperatures of 700 to 800°F. Apparently, evaporation does not take place in sharply defined phases as is the case with lighter oil at lower temperatures, but occurs gradually, producing a vapor of very high density. Nevertheless it is a vapor.

In Ind. Eng. Chem. 1925, pp. 1248-1249, in a vacuum distillation essay at 10 mm pressure, it is shown that a sample of 20.7°F A. P. I. was 98.5 per cent distilled at temperatures ranging from 161°F to 330°F. According to Table 16 of Bulletin 97, a 20° A.P.I. oil, distilled over by 10 mm pressure and 330°F, would have a heat content of 1127 Btu per gallon condensed, while the same oil evaporated at 760°F requires 3600 Btu per gallon or more than three times as much. This heat of 3600 Btu per gallon is certainly taken up, and can be verified by, with the fuel consumption. The explanation is that evaporation of the oil was not under vacuum but under pretty high pressure, somewhere around 40 or 60 pounds per square inch. The mixture, moving through the coil, has almost the velocity of gas, but the friction coefficient of a liquid and therefore encounters a rather high pressure drop. Nearer to the end of the coil, its pressure will approach the pressure in the vacuum tower and during this semi-adiabatic expansion, its heat will convert the vapors in regular superheated gases.

This heat balance, based on actual fuel consump-

(*Continued on page* 55)

Use of LIME in the Removal *of* Hydrogen Sulphide

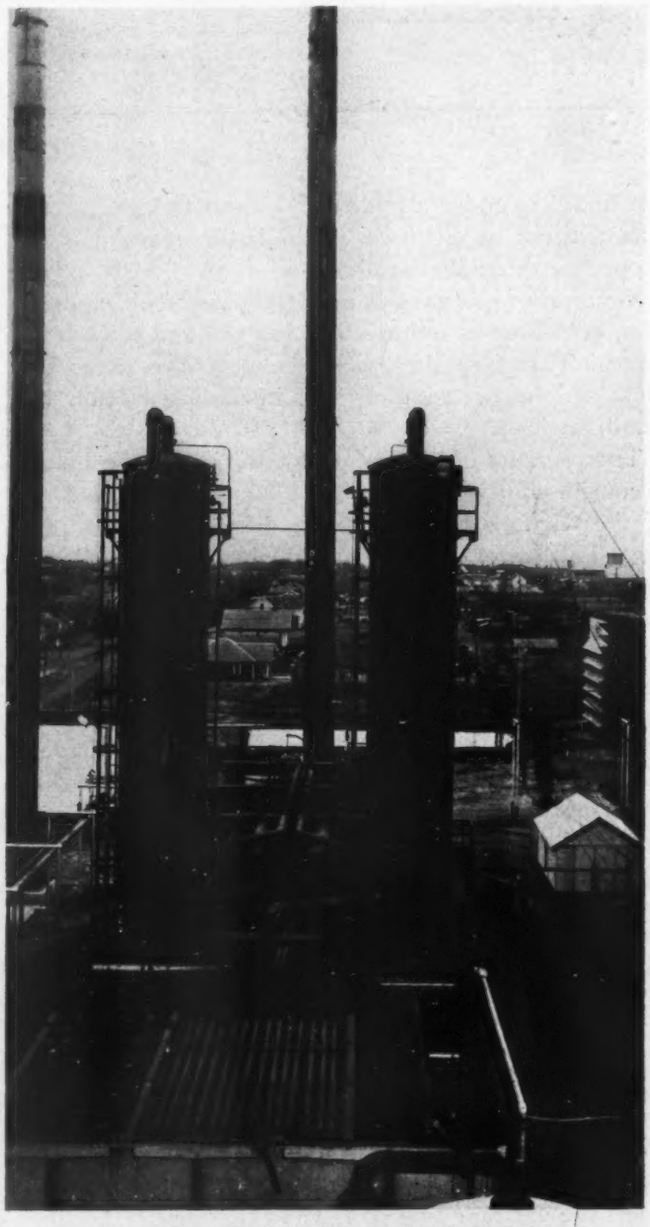
THE crude oil produced in the Garber field in Northern Oklahoma is normally sweet, analysis showing approximately 0.2 per cent sulphur. When processed in refining, either through straight skimming or ordinary cracking it does not produce corrosive compounds that will seriously effect the equipment. However, when Garber Refinery, Inc., at Garber, Oklahoma, began reforming a charging stock taken off in straight distillation, a stock of 300°F. I.B.P. with an end point of 475 to 500°F. with a gravity of 47 to 50 degrees A.P.I., corrosion began to show up in the vapor recovery plant, especially in the absorber.

The efficiency of the plant fell so low that very little natural substitute was being manufactured. Many things were blamed for the condition, and instead of merely getting bad, this condition rapidly became a serious proposition. By a process of elimination, it was discovered that the vapors arising from the reforming operation carried the disturbing substance. The temperature carried on the reforming tubes ran uniformly around 1010°F., sufficient to break down the sulphur content into hydrogen sulfide.

When the recovery plant was shut down and the absorber opened for inspection, quantities of a deposit of iron sulfide showing a red cast were found. The action of this substance was not noticeable through the condenser piping or vapor lines, but was limited to the absorber.

After experimenting with these vapors in the laboratory, it was found that they could easily be treated, sweetened and the hydrogen sulfide removed by passing them through a mist of saturated lime water. Two old clay towers were still standing on the original foundations. One of them was converted into a vapor scrubber by filling the shell with wood baffles. The vapors from the gas separator in the pressure distillate condenser system were led through this tower, entering near the base and merging from the top through a line leading to the original piping at the absorber. A liquid circulating system was installed, consisting of a small motor-driven centrifugal pump with the necessary pipe connections so that when the tower was charged with the solution it could be drawn from the base and discharged back over the top. A spider was placed on the inlet of the liquid line to distribute it evenly over the wood

(*Continued on page* 52)



Cracking Unit Converted to Redistillation System at Garber Refinery, Inc., Garber, Oklahoma

Remodeled Cracking Still *Reruns* Pressure Distillate

GARBER Refinery, Incorporated, Garber, Oklahoma, having a cracking unit on hand which had become obsolete through years of service, recently remodeled it to be used in rerunning pressure distillate. This pressure distillate is a combination of the products of regular cracking of reduced crude and gas-oil and that produced from reforming naphthas. (REFINER, Jan. 1933, 2).

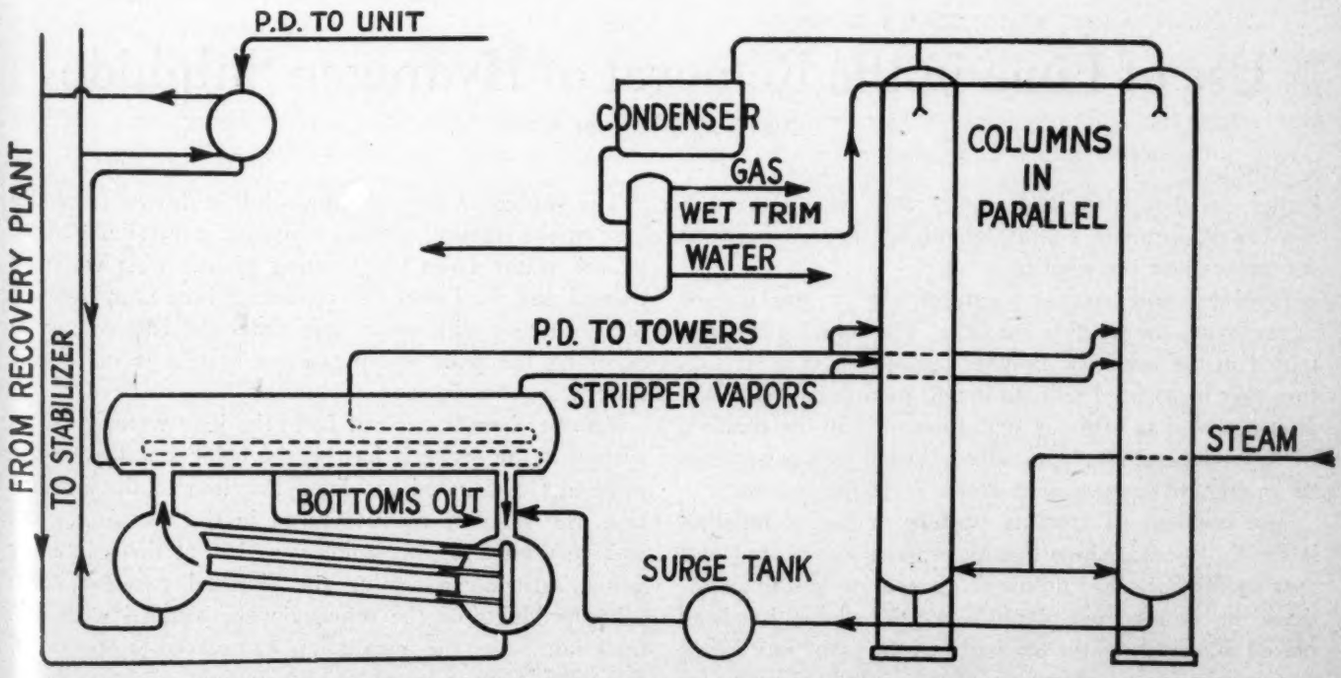
In a continuous process, the pressure distillate is debutanized to a four-pound product and treated in closed horizontal drums with three fourths of a pound of 66 gravity acid. It has a boiling range of 112°F. initial, to 414°F. end point. The gravity runs around 52.5° A.P.I. with a recovery of 98 per cent.

Leaving storage, this product is pumped through a shell and tube exchanger through which a circulating stream of still bottoms are pumped to preheat the pressure distillate before entering the submerged tubes in the horizontal upper shell of the old Jenkins cracking unit. The temperature of the bottoms is around 400°F., imparting enough heat to the fresh pressure distillate that when flashed off in the two towers it is almost stripped of the desired end point product.

These towers are the original set up, but rearranged so that they operate in parallel; the stream from the submerged tubes splitting as it is led from the shell. Each tower has 21 plates, six of which are stripper plates, and the upper 15 operating as fractionators. Superheated steam with a temperature of 450°F. is injected into the base of both towers to assist in stripping the bottoms.

The tower bottoms are introduced to the main shell or drum of the unit, entering at a point near the center of the connecting leg joining the main drum or shell with the lower tube drum. Into each bank of tubes which lead through the furnace and connect with the drum above the combustion chamber is fitted a superheated steam line with gates installed for manual control of steam. This serves two purposes: that of compelling circulation of the bottoms from the lower drum through the tubes, and being process steam at the same time.

Vapors stripped from the bottoms within the main drum are led to both towers, entering the shell below the point where the initial charge was introduced. Overhead streams from both towers are condensed in sub-



Flow Chart of Rerun Unit at Garber Refinery

merged coils with the product run to an accumulator, from which a stream is pumped back over the towers for wet trim, or reflux. The tops of the two towers are carried at 250°F. in order that a low end point product may be produced.

Only two products are recovered from this unit, the overhead stream from the towers and the bottoms from the main drum. The overhead condensate, the combined product of cracking and reforming has the following characteristics:

Gravity	56° A.P.I.
Color	30
V. P.	6 lbs. Reid
Octane Number	70
I. B. P.	102
10 per cent	158
20 per cent	200
30 per cent	220
40 per cent	248
50 per cent	266
60 per cent	300
70 per cent	318
80 per cent	336
90 per cent	364
95 per cent	380
E. P.	394
Recovery	98 per cent
Residue	1 per cent
Loss	1 per cent

After being rerun, the product is doctor sweetened and shows non-corrosive and has a light stability of six hours. It is blended with varying proportions of vapor recovery gasoline and straight run, depending upon the market demand.

The bottoms from the main drum are cooled and run to storage as a distillate having the following characteristics:

Gravity	38.4° A. P. I.
Color	Light Straw
I. B. P.	350
10 per cent	396
20 per cent	410
30 per cent	420
40 per cent	424
50 per cent	428
60 per cent	434
70 per cent	440
80 per cent	448
90 per cent	464
95 per cent	484
E. P.	512
Recovery	98 per cent
Residue	1 per cent
Loss	1 per cent
Odor	Good

Steam for process purposes and that used for circulation in the unit is led from the boiler house through insulated overhead lines to a bank of coils placed in the furnace, located in the rear of the combustion chamber just above the tubes leading from the lower to the upper tube drum.

Gas used for fuel consists of fixed vapors from the recovery unit, supplemented with natural gas from the field nearby. The fuel consumption is evidently very low, an examination of the flame showed that very little is necessary to maintan the temperatures necessary for manufacturing the two products removed in the operation of rerunning.

Use of Lime in the Removal of Hydrogen Sulphide

(*Continued from page* 50)

baffles, so that when the vapors were rising through the tower, intimate contact could be secured between the vapors and the solution.

Hydrated lime, costing around $15.00 per ton, is used in preparing the treating solution. The solution is maintained in the tower in sufficient quantities that circulation may be assured without losing suction on the pump. It is renewed as often as found essential in the removal of hydrogen sulfide, being strengthened by the addition of an amount equal to that drawn from the system.

The expense of treating outside of the installation is small. Records show that the vapors are treated at a cost of 50 cents per thousand barrels of gasoline produced in the recovery plant. Since the system has been placed in operation, the efficiency of the plant was raised to normal with no corrosion or iron sulfide showing up at any point in the recovery plant.

The sludge or surplus lime solution drawn from the base of the treating column is used in neutralizing some of the water from the treating plant. This water is treated and used over the condenser boxes, and with a pre-treatment with spent lime water the cost of reconditioning the plant cooling water system is materially lowered.

Another benefit derived from the lime water treating system is the effect it has on the color stability of the finished fractionated gasoline. Previous to the installation, the gasoline manufactured in the recovery plant was very unstable, becoming very low at times in color value, seriously affecting the finished gasoline when other products of the refinery were blended with this material. Since the installation was placed in operation, the color is not changed by time or light, and the operation of the plant as a whole improved and simplified.

Color in Gasoline *Has* Complex Nature

A. W. TRUSTY
Chief Chemist, Louisiana Oil Refining Corporation

MOST refiners are of the present correct opinion that color in itself has nothing to do with the quality of gasoline. The gravity and color tests in the earlier days of refining were considered important factors in the judgment of the quality of a motor fuel. Long ago, however, the Federal Specification Board, which rigidly safeguards the quality of the gasoline purchased by the government, has dropped these two tests from its specifications. The general public, in the past, has been educated by the refiners to expect a water white gasoline, and the refiner now has either to produce a good white gasoline or market a red, blue, orange, green or other colored gasoline. Most refiners recognize that an "off-color" gasoline is hard to sell when competing with a water white or a brightly colored gasoline. The refiner who has not yet gone to a colored motor fuel still has the expense and trouble attendant on the production of a 25+ color.

NATURE OF COLOR

The few colored hydrocarbons that are known contain conjugated unsaturated groups, as in the hydrocarbons of the fulvenes series. The fulvenes range from a yellow to an orange color.

Gray and Drogin[1] state that pure hydrocarbons are colorless, but become colored upon oxidation, especially upon oxidation of the unsaturated members. Leuco bases, while colorless themselves, yield color bases upon the addition of a single atom of oxygen. This color base is also colorless, but has the power to unite with certain other elements or groups to give colored compounds. Again, color may be due to groups known as chromophores. This is the name given by Witt to certain unsaturated groups of atoms which have a powerful influence in producing color and are necessary for such production. The chromophores unite in turn with other groups of elements, and form larger groups also essential to color, known as chromogens. These chromogens may be colored or not; if colorless they are capable of uniting with other groups known as auxchromes which give to the molecule both color and the power to form salts which are colored. NH_2 and the OH groups are examples of auxochromes. In general the depth of color in organic compounds is directly proportional to the molecular weight.

Ellis, U. S. Patent 1,318,061, observes that the action of acid is often responsible for discolored products due to the formation of dye stuffs soluble in gasoline. His process covers the use of dilute sulphuric acid of 40 to 70 per cent strength.

Brooks[2] states that when petroleum distillates darken by air oxidation, amorphous asphalt-like substances are formed. It is improbable that these coloring matters are hydrocarbons, since the few colored hydrocarbons which are known contain conjugated unsaturated groups, as in the hydrocarbons of the fulvene series. Some writers regard the removal of such coloring matter by sulphuric acid as a purely physical or colloidal phenomenon.

A hydrocarbon of the formula $C_{15}H_{22}$ and containing four double bonds has been described by Sherndall[3] as having an intense blue color and accordingly named azulene. A. Homer obtained a red colored hydrocarbon, having the composition $C_{26}H_{22}$ in small quantity as a by-product of the reaction between naphthalene and aluminium chloride, which he termed tetra-methylerythrene.

VAPOR PHASE CLAY TREATMENT

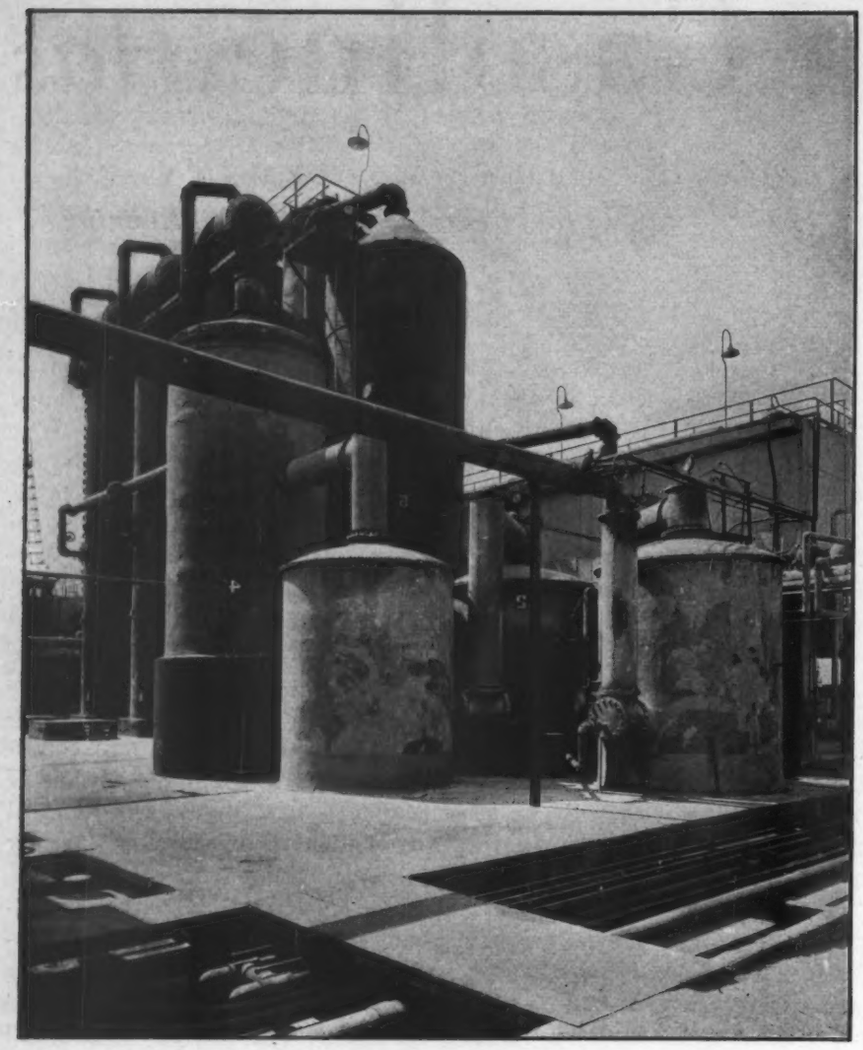
Many refiners have been using for several years the Gray Vapor Phase Process. This process has been successful in producing a finished motor fuel (with the exception of a doctor sweetening operation) directly off the cracking unit. Essentially, the hot cracked distillate vapors are passed through a tower of clay and thence to the condenser box. (REFINER, **11**, 2, Feb., 1932, Page 180.)

The clay, acting as a catalyst, polymerizes the objectionable unsaturated hydrocarbons. These polymers, due to their high boiling point, are separated from the other vapors. The nature of the polymers is shown by the following tests

Gravity	45.0
I.B.P.	185
End Point	550
Gum	1980 mg.
Color	Dark brown

On exposure to air these polymers gradually harden into a shellac-like gum.

The yield of gasoline per ton of clay varies from



Lachman Treating Process

1,000 to 12,000 barrels of gasoline depending on the type and extent of cracking. The gasoline produced is 25 to 30+ in color and is stable to the light.

THE ZINC CHLORIDE PROCESS

A process which has recently been developed and which gives promise of being a successful method of treating cracked distillate, is the vapor phase zinc chloride process.

Essentially the system consists of passing the cracked distillate vapors at a temperature of about 400°F. through a 50 per cent solution of zinc chloride, then fractionating and condensing the gasoline. The zinc chloride polymerizes the unsaturated hydrocarbons, forming a sludge which separates in the mixer. Due to hydrolysis of the zinc chloride solution a small amount of acid is formed which is neutralized with limestone or ammonia. The treating loss is very low, the consumption of chemical per barrel of oil is low, the loss in octane number due to treatment is negligible, the color is 30, the sulphur is partially removed depending on the types of sulphur compounds present the gum is low and the odor good. (REFINER **11**, 2, Feb., 1932, Page 182.)

ACID TREATMENT

The majority of the refiners remove the undesirable coloring matter of cracked distillates by acid treatment and rerunning. The distillate is contacted with from 1 to 12 pounds of sulphuric acid and pumped to suitable settlers in order to drop out the sludge. Sulphuric acid of 93 per cent acidity (66 Be) is usually used although some refiners advantageously use a weaker acid of 85 per cent acidity. The distillate is water washed, neutralized with caustic soda and rerun to an overhead of desired end point. REFINER, **11**, 2 Feb., 1932, Pages, 168 to 178).

The effects of the various treating and rerunning conditions on the color of the rerun overhead are summarized:

1. Excessive time of agitation of acid with distillate causes a poor color on rerunning.

2. The temperature of acid treatment, providing the time of agitation is not too long, has very little effect on the color of the rerun overhead.

3. Prolonged settling time before caustic neutralization tends to lower the color of the rerun overhead.

4. The strength of caustic used to neutralize the distillate has no effect on the rerun color.

5. The water wash before caustic neutralization does not affect the color of the rerun overhead.

6. Storage of acid treated distillate before rerunning improves the color on the rerun overhead.

7. In general, the more steam used in the rerunning operation, the better the color of the overhead.

The effect of using varying amounts of sulphuric on color is shown by the following:

Lbs. of acid per bbl. of oil	Color of rerun overhead
0	8
1	15
2	17
3	21
5	24
6	25+
9	23
10	21
15	20
20	20
40	20

These tests show that there is an optimum amount

of acid to use to obtain good color, and greater or lesser amounts of acid give a poor color.

COLD CONTACT WITH CLAY

Some refiners use the acid and clay method of treatment which has proven satisfactory for certain types of cracked distillates. The process consists of treating the distillate with a small amount of sulphuric acid, usually .5 to two pounds per barrel. The distillate is caustic washed, allowed to settle in order to eliminate as much moisture as possible and then contacted with clay. The clay treatment alone would remove the coloring matter from some types of distillate, but by using a small amount of acid, less clay is required to obtain the same color, and a slight reduction in sulphur is effected.

In order to completely free the gasoline from the minute particles of suspended clay which settle slowly, it is filtered through a filter press. The finished gasoline is 25 to 30+ color and has a satisfactory stability to sunlight.

The applicability of this treating method, which eliminates a rerunning operation, is of course limited to a lightly cracked distillate that has a relatively low gum and sulphur content.

There are several modifications of the use of clay by cold contact, for instance, where the clay is used instead of caustic to neutralize the acid oil after a light acid treat (Refiner, **11**, 2, Feb., 1932, Pages 168, 172).

LOSS OF COLOR IN SUNLIGHT

All petroleum products are acted upon, even at ordinary temperatures, by the oxygen of the air: they become yellow and turbid, deposit flocky precipitates, and acquire a more or less pronounced acid reaction. The unsaturated hydrocarbons and those of the other groups with high molecular weights and branched chains are more susceptible to oxidation than are the normal paraffin, naphthene and aromatic hydrocarbons.

Weger[4] has shown that pure saturated paraffin hydrocarbons are oxidized by the oxygen of the air in sunlight. Hydrindene acquired a strong acid reaction, yellow color and an oxygen content of 8.8 per cent. Toluene, which had been exposed to light for a year, contained 12 per cent benzoic acid and a little benzaldehyde. M-xylene contained 31 per cent toluic acid with a little formic acid and m-phthalic acid after the same exposure.

Part of the substances formed when kerosene is exposed to sunlight is believed to be asphaltogenic acids. Formic and other acids are also formed. Sulphurous and sulphuric acid is formed when acid treated or acid treated and rerun distillates are exposed to sunlight, due to decomposition of the alky sulphuric esters formed during the treating operation.

Brooks and Humphrey[5] have shown that oxidation is greatly accelerated by the presence of sulphur containing compounds. Doctor treated gasoline, whether straight-run or cracked is very unstable to light if a large excess of free sulphur is used to "break out" the doctor. Oxidation[6] is also accelerated by such catalysts as charcoal, copper, brass and phosphor bronze. Catalysts which are less active are nickel, cobalt, steel and cast iron. Zinc and aluminum do not influence oxidation. Oxidation is accelerated by sunlight or may even be initiated by sunlight. Temperature also accelerates oxidation.

The greatest cause for the yellow color when gasoline darkens probably is due to polymerization of the unsaturated hydrocarbons.

STABILIZATION WITH INHIBITORS

Chemical compounds have been investigated that inhibit the darkening of gasoline on exposure to light. Some of the compounds which have proven successful are anthracene, DuPont No. 2, gum camphor, phenanthrene, psecudocumene, acenaphthalene, fluorene, B-naphthol, tetraline, phthalimide, urea and naphthalene. It has been observed that chemical inhibitors are effective with some gasolines and not effective with others under the same conditions.

[1]American Pet. Refining—Bell.
[2]Non-benzenoid Hydrocarbons—Brooks.
[3]J. Am. Chem. Soc. 37, 1537 (1915).
[4]Berichte, 1903, 309.
[5]Jour. Ind. Eng. Chem., 1917, 746.
[6]Chemiker-Zeit. Rep., 1922, 34.

Heat Flow Diagram of a Two-Stage Distilling Plant

(*Continued from page* 49)

tion, proves that vaporization really takes place under these high temperatures and higher pressures and the conclusion that is drawn from this fact is, that in order to get the full benefit of low pressure fractionation, say at 10 mm, it would be necessary to evaporate at very low pressure and to allow only a very small pressure drop.

The assumptions, on which these calculations are based have been sufficiently proven. The overall balance, is as follows:

Formula 5

$$F_1 + F_2 + \text{steam} = S_1 + S_2 + W_1 + W_2$$

OVERALL HEAT BALANCE

Heat Produced in Atm. Pipe Still, F_1	48,000,000 Btu
Heat Produced in Vac. Pipe Still, F_2	28,800,000 Btu
Steam, 4000 lbs. at 15 lbs./sq. in.	4,520,000 Btu
Heat leaving in flue gases, S_1	11,047,990 Btu
Heat leaving in flue gases, S_2	7,079,920 Btu
Heat leaving in water, W_1 W_2	63,192,090 Btu
Heat in: 81,320,000 Btu = Out: 81,320,000 Btu	

This heat balance includes only process steam; no steam for mechanical devices is entered, such as pumps and jets, as the amount of steam used by these devices depends largely upon mechanical perfection and is not influenced by the process.

The economic use of fuel is all-important in plotting new installations and a heat flow diagram is of great help as it indicates where wasted heat may be returned to the process.

A. S. T. M. End Points . . . *Relationship Between* End Point and True Boiling Point

A. J. GOOD and A. J. CONNELL
E. B. Badger & Sons Company

THE development of laboratory equipment for precise petroleum assay work was not altogether a gradual development of definite equipment. The time of development can well be divided into two periods with the end of 1925 marking the end of the first phase and the beginning of the second.

Prior to 1926 various types of still-heads had been used, the effectiveness of each varying with the type. Without exception heat loss from the wall of the still head was the means of inducing reflux, and the contact of this reflux with the rising vapor was imperfect or limited. Still-heads of the Hempel type, either filled with beads or with jack chain, were used as the most effective known tool. Certain laboratories used small shell stills fitted with packed columns. Reflex was induced by wall condensation and an attempt was made to distribute the reflux so formed over the packing.

The first column for precise high temperature assay work was described by Peters and Baker[1] in 1926. The application of this column to petroleum analysis was outlined by Peters and Leslie[2] the same year. This type of column, modified for vacuum work, is generally used at present for accurate boiling point analysis of all types of materials boiling normally above about 100°F. A column, similar in principal but different in design, was described by Leslie and Geniesse[3] for low temperature distillation. This low temperature column was subsequently modified by Leslie and Podbelniak and, with modifications, is used in the analysis of low boiling materials.

The column described by Peters and Baker has become a powerful tool in the equipment of petroleum chemists. Although materials boiling up to 500°F. can be handled in this "standard" column, or "true boiling point" column, the most useful application is in the range of gasolines and naphthas. With proper precautions as to rate, reflux, and maintenance of unrestricted vapor space at the point of support of packing rings, results are accurate and easily duplicated.

Operation of the above described equipment on many types of oils over a period of years has brought to light at least one correlation and one discrepancy between the cut point of the standard column and the A.S.T.M. end point of the overhead produced. It was observed that when a cut was made up to a vapor temperature of say 450°F., the end point of the distillate produced was always below the cut point, but that when the cut was made at 300°F., the reverse was true. Beiswenger and Child[4] reported end points of 390°F., for 400°F. cut point, and 320°F. end point for 320°F. cut point. Plotting the results obtained with various materials gives the curve shown in Figure I. This curve represents the normal relationship within the limit of experimental error.

The temperatures shown for the cut point are true temperatures obtained either by means of calibrated thermocouples, or three-inch immersion thermometers checked against Bureau of Standards certified thermometers. The temperatures shown for the end point are those obtained in the standard A.S.T.M. distillation test run with total immersion thermometers.

End points of gasoline below the cut point can be explained as the cumulative effect of incorrect temperatures, and the loss of higher boiling materials during the A.S.T.M. distillation. Due to the fact that only a portion of the stem is immersed in the A.S.T.M. distillation, although the thermometer is calibrated for total immersion, an appreciable error may be introduced in the true end point reading. Previous work in this laboratory indicated that this error became larger as the temperature increased until at 450°F. the A.S.T.M. reading was 11°F. below the true temperature.

It is more difficult to explain why the end point of a fraction should be above the cut point at cut points below 380°F. A possible explanation was that the fractionation of a low boiling cut offered more difficulty, that heavy ends were present in the cut, and that the high end point was due to the presence of such heavy ends. As a check on this possibility, samples of commercially pure compounds were redistilled in the column under heavy reflux and a middle cut taken for A.S.T.M. distillation. This procedure eliminated the possibility of heavy ends, and effects which might have been attributed to higher boiling materials were shown to be due to some other cause.

[1]Ind. Eng. Chem., 18, 69, (1926)
[2]Oil Trade, 17, No. 5, 37. (1926)
[3]Ind. Eng. Chem., 18. 590 (1926)
[4]Ind. Eng. Chem., Anal. Ed., 7, No. 3, (1930)

BEHAVIOR OF PURE SUBSTANCES IN THE A.S.T.M. DISTILLATION

A.S.T.M. distillation of the samples produced on the standard column from commercially pure compounds showed some remarkable facts. Carbon tetrachloride did not reach its maximum temperature until 30 minutes after the 95 per cent point had been reached and the full flame applied. Benzol reached its maximum 17 minutes after the 95 per cent point, and toluene 15 minutes after the 95 per cent point. The time-temperature relationship for toluene above the 95 per cent point is shown in Table I as an illustration. A general summary of the results of A.S.T.M. distillations of pure compounds is shown in Table II.

TABLE I.
Time Temperature Relationship for Toluene Above the 95 Per Cent Point

Time	Temp. °F.
0	230
3	262
5	277
10	300
15	310

TABLE II.
A.S.T.M. Distillations of Pure Compounds

Material	Standard Column Range	A.S.T.M. 95%	S. P. or Maximum	Difference Cut Point and End Point	Time from 95% to Max. Minutes
Carbon Tetrachloride	170-170.5	170	280	110	30
Benzol	176.5-177	176	301	124	17
Toluene	229-230	230	310	80	15
Xylene	279-282	282	311	29	4
Butyric Acid	325-326	322	346	20	3½
Aniline	364	356	372	8	3

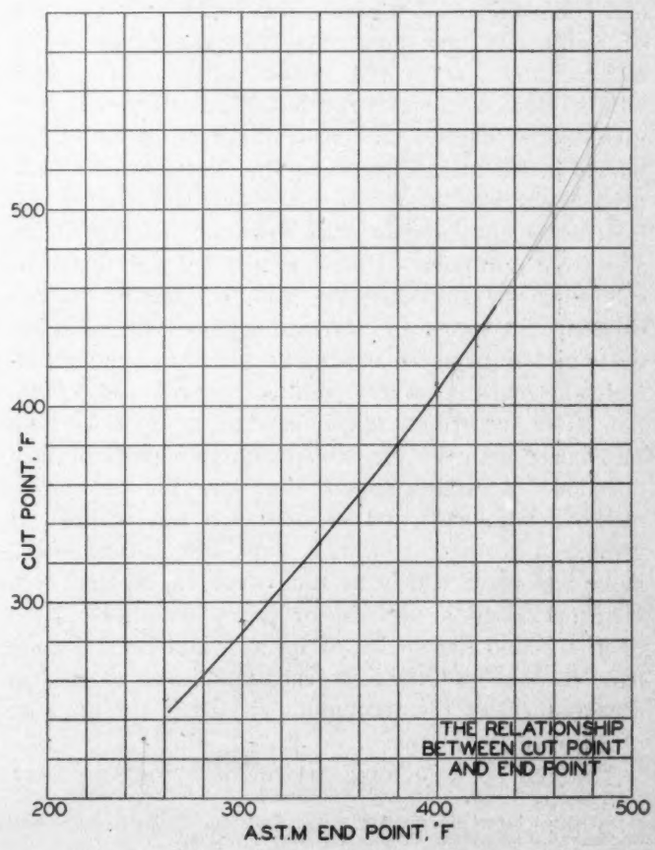
The maximum temperature reached by the low boiling compounds is about 310°F., and appears to be relatively independent of the actual boiling point of the compound. It seems probable that radiation from the hot bottom of the flask to the thermometer bulb is responsible for the considerable elevation of the end point above the cut point, and for the long time to reach a maximum reading. At about 310°F. the radiation from the bulb to the neck of the flask apparently balances the radiation received from the bottom of the flask. The extent to which the maximum point would be raised, due to radiation, would depend upon the intensity of heating, which, in turn would vary with the burner adjustment and might vary with different operators.

With butyric acid and aniline, boiling above 310° F., the end point is still above the cut point, but by a smaller amount, and the time required to reach the end point is within the limit of five minutes from the 95 per cent as stipulated in the A.S.T.M. procedure. Furthermore, the end point in these cases is a definite one, as evidenced by the attaining of a maximum reading and a subsequent decrease. In this range, superheating of the vapors is a probable cause of the elevated end point. When most of the vapor has been expelled from the flask, and there is no longer sufficient circulation within the flask to carry heat from the bottom to the bulb, a decrease in the thermometer reading is observed. The effect is quite different from that observed with the low boiling compounds, where the rise in temperature continued long after the flask was dry, and where the temperature reached a maximum but did not fall within the time observation was continued.

CONCLUSIONS

Two interesting and important conclusions can be drawn from the data given; first, the A.S.T.M. end point of low boiling material is probably higher than the true end point; and second, the effectiveness of separation, as judged by A.S.T.M. analysis of successive cuts, actually varies with the temperatures of the cuts in question. It is obvious that if the indicated end point of the first cut is too high, a much sharper separation must be made in order to show a gap between the low boiling fraction and the next higher boiling fraction. In the same column, and with approximately the same reflux, the A.S.T.M. distillations indicate poor separations between low boiling cuts, and good separation between high boiling cuts.

A.S.T.M. analyses, therefore, cannot be used as a criterion of effectiveness of separation without consideration of the temperatures involved. Further study of the relationship between dry point and end point may be necessary if the present trend of lower end point gasoline continues, and steps may have to be taken to eliminate superheating and radiation effects.



Cost Accounting *and the* Chemical Engineer

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H. W. JONES*
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DURING the past 20 years a continual conflict between accountants and technical men has smoldered beneath the surface of industry, characterized in its earlier stages by considerable intensity of feeling, but recently simmering down to a friendly recognition of different points of view and a joining of forces to attain mutual objectives. That this strife should have occurred is not surprising. The accountant, steeped in the tradition of an age old profession, and accustomed to regard himself as the confidential steward of his employers and his ledgers as sacred records to be exhibited only to the members of the firm, could hardly be expected to welcome the prying inquisition of the technical upstart to whose scientific spirit nothing was sacred. The one was essentially a tory and ultra-conservative; the other most certainly a progressive, and to the minds of many, a radical. In this case industrial history has vindicated the latter.

Within the last century industrial processes have gone through a stage of rapid evolution, and progress has always been in the direction of increasing size and complexity. As a result, the design and operation of equipment have proceeded from the hands of the owner into those of the modern manufacturing staff with its numerous highly specialized sub-divisions. Intimate knowledge of design and operating detail has moved in the same direction. The executive of a hundred years ago based his decisions and shaped his policies largely upon his own knowledge and experience, and from our point of view leaned but lightly on his subordinates. The decisions and policies of today's executive are based on information provided almost entirely by the members of his staff, for the soundness of which he relies far more upon the character and reputation of the contributing individuals than upon his own familiarity with the various specialized aspects of each question. It would appear that had the accounting methods kept pace and in step with this manner of growth, information would have been disseminated more and more widely as time went on, so that each contribution to a decision or policy would be based upon a sound knowledge of its own and general company economics. Only in recent years, however, has the conservatism of the accountant yielded to the pressure of changed conditions.

The general accounting system of a company periodically lays before the general management balance sheets and operating statements showing the current assets and liabilities, the gross income, the cost of selling, the cost of manufacture, and finally the net profit for the period. The cost system has contributed nothing to these figures except the evaluation of inventories of partly finished and finished goods, which is necessary to determine profit or loss. The total of the expenses distributed by the cost accounting procedure must, of course, equal the total expenditures shown by the general accounting system.

In the past the average cost system has been a post-mortem instrument—an analysis intended to show the extent to which individual activities had contributed or failed to contribute to a successful showing. Such statements represented water-over-the-dam, and insofar as they covered extensive periods contributed little or nothing to day-to-day economy and good judgment in handling current exigencies. They did provide, however, information upon which decisions concerning long time policies could be based, and in addition served as a point of departure for investigation into the *past* efficiency of the various phases of management.

To the sales manager were presented the cost of making sales, the manufacturing cost of the goods sold and the income from their sale. Apart from the question of selling expense, which we will not consider here, it appeared a simple matter to supply all the information needed to determine the success of his past and the direction of his future efforts. Obviously what he wanted from a manufacturing cost system was a cost per pound or per gallon of each product. Unfortunately individual unit costs in many cases do not exist in fact, and so cannot be calculated. This is always the case where the members of a group of finished materials are dependent for their production one upon the other. It does not matter that some one or more may be called by-products, or that one may incur more expense than another, the only calculable thing by the very nature of the operation is the total cost of making the group. Moreover, the sales department must dispose of the entire group in the relative quantities made. Consequently, in the last analysis the sales manager must compare what he can

*Presented before the meeting of the American Institute of Chemical Engineers, Washington, D. C., December 7-9, 1932.

get *for the group as a whole* with what it cost to produce and market it. In addition to the above, he wants to know how costs vary with volume of production. A system which presents costs sub-divided into items independent of, and those varying with volume of production will help intelligent consideration in this direction, but since the variations are neither regular nor in the same ratio throughout the production range any major variation must be made the subject of independent study. Further, when the variation in volume is due to the deliberate idling of equipment because of lack of demand, certain items, notably depreciation, cease either partly or altogether to be factors of production cost, and instead take on the color of bad debts to be swallowed whole with the best possible grace.

The purchasing agent usually has no direct active interest in cost statements, but under a type of management to be discussed later he may be made aware of the value of his contribution to the general welfare.

We come now to the manufacturing manager—nowadays, at least in chemical plants, a chemical engineer. Cost statements, to be useful to him in controlling his plant, must reflect *currently* the economy with which his operations are conducted so that inefficiencies may be detected as soon as they occur and promptly remedied. By the same token the statements must be arranged to enable him to hold his subordinates to a strict accounting for each delegated responsibility. In addition to actual plant operation the manufacturing manager will participate in all questions of policy with the sales and financial managements, and with the general management. Such questions as the addition of new products to the company's line, increasing or decreasing the volume of business in this or that direction, improvement or expansion of present processes or facilities and so forth are all referred to him for study and comment. Here he assumes the role of economist in his own sphere, estimating the results of changes in a complex situation wherein the change, directly applying only to a few things, indirectly affects all. It is evident that the ease with which all this can be done will depend greatly upon the skill with which the statistics are gathered and arranged to meet his varied requirements.

It is this field of activity, that of the manufacturing manager, which the cost accountant has been tardy to recognize as legitimate in all its phases. It has appeared to him a dangerous thing to broadcast, relatively speaking, values hitherto known only to the higher officials, and he has naturally felt that the cultivation of any such policy would automatically tend to undermine his time-honored role of financial analyst and confidential investigator. When manufacturing units were on a small scale the locations of office and factory were often identical, and it was possible for the accountant to keep physically in close touch with plant operation and plant management; the combination of individual units geographically wide-spread to form large corporations under centralized "head-office" control has often destroyed both personal and physical contact, at once increasing the accountant's, and decreasing the plant manager's reliance on statistical information—an unfortunate thing for both. The very neglect of this field by his more conservative associates made it an especially attractive market for the consulting accountant, who, forgetting tradition, saw the situation as it really existed, and devised systems which would meet the requirements of *plant* management and at the same time furnish reports for the *general* management in such form and substance as to make plant operations more intelligible, and investigation more immediate, direct and penetrating. As a result, we now have in our hands the glittering new tools, variously named "standard costs," "budgetary control," etc.

Having had a mushroom growth, all these systems are fundamentally as alike as one mushroom to another—slightly different in size, shape and color, perhaps, but basically of the same stuff. The aim of all is to provide for each operation, for each group of operations and for the entire plant, a series of measuring sticks by which actual performance may be scientifically evaluated. In place of the multitude of comparisons presented by past history with all its attendant modifying circumstance, they apply definite, previously agreed upon standards—not definite in the sense of being invariable, but on the contrary constantly variable in order to give a true, up to the minute basis for comparison. To take one of the simplest cases: if production figures are to be compared at the end of each calendar month, the volume in February will be less than in January, and the system automatically shortens the measuring stick in the ratio 28:31. And another: the change in price of raw materials is out of the control of the factory management; what control is applicable is in the hands of the purchasing department. The system recognizes this, and automatically separates the fluctuation in total cost due to increase or decrease in the price of raw material. Thus the official studying the statement loses no time in questioning the manufacturing manager regarding increased costs due to price changes—the system immediately and automatically turns his head in the right direction—i.e., to the purchasing department. Still a third example: to the extent that cost may be shown to be above or below standard due to change in production rate the responsibility may lie either with the manufacturing or the sales department, or with business conditions entirely beyond the control of either, as inquiry will bring out. Thus these systems purport first to separate the constant and variable items of cost, then automatically to show to what extent the total variation of each cost from standard was influenced by each of the various factors affecting cost, and finally to lay automatically each variation at the feet either of the responsible individual or of Providence, as the case may be. This is a consummation for which all executives have, or should have, devoutly wished.

But cost departments are expensive—what about the increased cost of the costs themselves? Here again these new systems have followed the trend of modern in-

dustrialism. By focusing expert, intelligent and intensive study on the problem beforehand and by applying a few simple principles, an automatic system of analysis is devised whereby the computation of periodic analytical statements becomes a mechanical routine easily performed by relatively inexpensive labor. The thinking is done beforehand; the clerical force adds, multiplies and divides, and enters the results in the right column.

The establishment of proper standards is obviously an important factor in the practical application of such a system, and may proceed from one of several points of view. Each standard may epitomize past history; it may be an ideal more or less unattainable in practice, as were the carrots hung before the donkey's nose; or it may be a reasonable expectation for a given period, arrived at by consideration of past history, current values of raw material and labor, and present and potential sales demand. The advantages of the first two points of view must be left to their proponents; what follows deals with the last since it involves a general method of management to which the particular cost system used is merely an incidental aid.

This method consists in:

1. A detailed forecast of production based upon a similar forecast of sales over a period the length of which depends upon the degree of control required to cope with the business fluctuations generally encountered in the particular industry.
2. An estimated direct cost of each individual operation involved in the production of the forecasted quantities.
3. An estimate of each item of indirect cost—i.e., of each item of burden or overhead.
4. The periodic preparation of statements which compare actual with anticipated results.
5. Comparison of actual and anticipated performance, explanation of the variations, and correction of faulty procedures—all by the individuals directly responsible.

The production forecast permits the scheduling of raw material deliveries, the determination of appropriate inventories to insure uninterrupted operation and delivery of finished goods, and should result in tying up the minimum amount of capital in all inventories. To prepare it, reliable data on plant capacity and process yields are, of course, essential, and for these the manufacturing manager must rely either upon past experience or upon test runs made for the purpose.

All costs fall under one of two headings: those which apply to one operation—direct costs, and those applying to more than one—indirect costs. In order to make possible the automatic analysis by the accounting system of the effect of change in production rate, each separate item, such as labor, repairs, fuel, etc., of both direct and indirect cost, is split into two components: (1) That part of the cost item which varies directly as production rate changes, (2) that which varies independent of production rate.

Plant management is not greatly interested in the distribution of indirect costs so that each product or group of products may bear its proportionate share of the total burden, but rather in seeing that the *total* of these various expenses is reduced to a minimum. The one way to do this is to consider each item of indirect expense in toto—as a separate and distinct entity. For example, it is much easier to comprehend and thus to control the cost of supervision when it is considered as a total than after it has been distributed over a half dozen products or processes. In fact, no statement used for purposes of plant control should contain any figures resulting from a proration, even though it represent an item of direct cost. Proration of what should be direct costs is frequently rendered necessary due to lack of measuring means—for instance, a common fuel bin or a common steam line supplying two independent operations—but the necessity arises in figuring the cost and not in controlling the consumption of fuel or steam. For the latter purpose the sum of estimated consumptions must be compared with the one actual measurement, otherwise an estimate is being compared with an estimate. The previous examples are simple, but the same reasoning applies to more complex situations. An entire battery of equipment, i.e., an aggregation of similar individual units, may simultaneously handle a number of raw materials and make a corresponding diversity of finished products under the supervision of one foreman, operated by the same gang of men, and supplied with fuel, power, etc., from a common source. The primary statements for plant use will show the cost of running the battery as a unit, and the determination of comparative economy will depend upon the accuracy with which the contribution of each different operation to the total cost can be estimated.

This method of plant management then consists first in the cleancut delegation of responsibility throughout the organization; it entails a forecast or budget of production volume, rate and cost over a suitable period, itemized to correspond with individual responsibility; it entails a parallel record of accomplishment; and finally it furnishes to individuals and groups of individuals a statement comparing the anticipated with the actual results of their particular activities. It does not stop at superintendents or foremen but reaches down to the individual operator or group of operators. The whole scheme is directed towards using to the limit the abilities of every employe and making it possible for him to employ to the fullest extent whatever initiative and native intelligence he may possess. If the plant is adequately equipped with measuring instruments a foundation is laid for bonus incentives, which usually put a keen edge on those qualities either in the individual or in the group. The standard cost system makes the method workable inasmuch as it automatically separates factors beyond the control of the individual, leaving bare those which are affected by his judgment and intelligence. Further-

more, it makes possible the detailed routine analysis of great masses of operating data at a minimum of expense.

Insofar as the plant manager is required to play the role of economist and to estimate the effect of proposed changes, the raw material for the job is readily available and in excellent arrangement. No matter what the innovation may be, one broad question is invariably presented: how much will the total outgo be affected and how much the total income? In a large plant manufacturing a diversity of products, the individual processes are inextricably tied together by their dependence upon mutual facilities—shops, trackage, roads, steam and power plants, water pumps, laboratories, etc., and upon mutual labor, supervision and management. The total cost of increasing or decreasing production from any one process is practically never directly proportional to current volume and cost, since every item of expense, both direct and indirect, may be affected to a different extent and require separate consideration. The effect of such change on any one of the various items of mutual or overhead expense can only be arrived at from consideration of the total of each, and not some portion thereof more or less arbitrarily alloted to the process in question. The plant manager never need concern himself with the distribution of overhead expense; he has before him the tangible cost of each plant activity in its entirety, and he or some member of his force knows the nature of it in detail and can determine to what extent changes in the processing of any item of production will affect it.

The value to any one of routine finished costs—i.e., costs carried down to individual products or groups of products with all mutual items of direct and indirect expense allocated by a set scheme of proration—is highly debatable. The intricately woven result usually contains so much shoddy in the way of arbitrary assumptions as to make poor fabric for decisions materially affecting dividends. Possibly better to present every question to an economist with the raw material of specific expenditures at his command, and allow him to arrive at an answer after taking into consideration not only plant costs but also general business conditions as they affect each case and each item of cost.

Cost systems have always been considered a device of accountants, and insofar as they have failed accurately to reflect the truth, that failure has been laid on the accountant's doorstep. As a matter of fairness it should be stated and emphasized that the plant designer and operator is responsible for the commonest and most important cause of inaccuracy, and for squandering a vast amount of labor in arriving at approximations in place of ascertainable fact. The foundation of any cost system is the accurate measurement of material quantities. Were it possible so to design a plant that every pound, every gallon, and every cubic foot of material consumed or produced in its operation were accurately measured, 90 per cent of the design of a cost system is there completed, and a mass of information made available the practical value of which cannot be destroyed by the most sterile accounting procedure. Nowadays the design of chemical plant equipment, insofar as that design influences the attainment of the desired chemical, physical and economic result, is most often the work of the chemical engineer; from that point of view, the chemical engineer who designs a plant or an installation of equipment must accept the major part of the responsibility for the records which will render possible intelligent operation and control. In other words, he must visualize the economics of each operation for which he designs equipment, and taking into consideration the value of each item of consumption or production, provide means to measure it within the limits of accuracy demanded by its value and the cost of the means employed.

Of course, if plants are considered as entities apart from individual processes or pieces of apparatus, most of them are in fact not products of deliberate design. To a greater or less extent they "just grow" as they are required to meet changing demands, and usually become a speaking record of uncontrolled individual judgment and lack of centralized planning. The possibility of measurement is lost in a maze of old pipe lines, common fuel bins, inadequate tankage, and so forth, and in faulty instrumentation. In such cases the technical management has effectively removed the underpinnings of the cost system, and they cannot be replaced by any clever scheme of proration or estimation.

Thus, the chemical engineer either in the role of designer or operator must accept the major part of the criticisms now so often directed entirely at the cost accountant, and of the engineer that ancient question may well be asked: "And why beholdest thou the mote in thy brother's eye, but considerest not the beam that is in thine own eye?"

The foregoing omits tables and other data pertinent to this discussion, which will constitute a second installment to appear in the March issue.

Utility of Graphical Charts in Design and Operation

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Houston, Texas

MUCH of the work of calculation done by the engineer or designer is in the repeated application of a limited number of formulae to a variety of different conditions, which involves merely the substitution of different variables in identical equations.

Any mechanical means for performing this operation expeditiously will not only lead to a saving of time and mental wear and tear but will also minimize the chances of error.

Such a device is the calculating chart or nomograph and the increasing frequency with which it is employed in the more recent publications is a good evidence of the growing recognition of its value.

As an example of short cutting the writer has constructed a series of charts illustrating the tabular work carried in the United States Department of Commerce—Bureau of Standards Miscellaneous Publication Number 97—"Thermal Properties of Petroleum Products." These charts are constructed first on rectangular coordinates and secondly as alignment charts in order that readers may have their choice of chart to suit individual preference.

Chart No. 1 is plotted on rectangular co-ordinates to cover the specific heat of petroleum oils of various gravities in Btu per pound and per gallon per degree

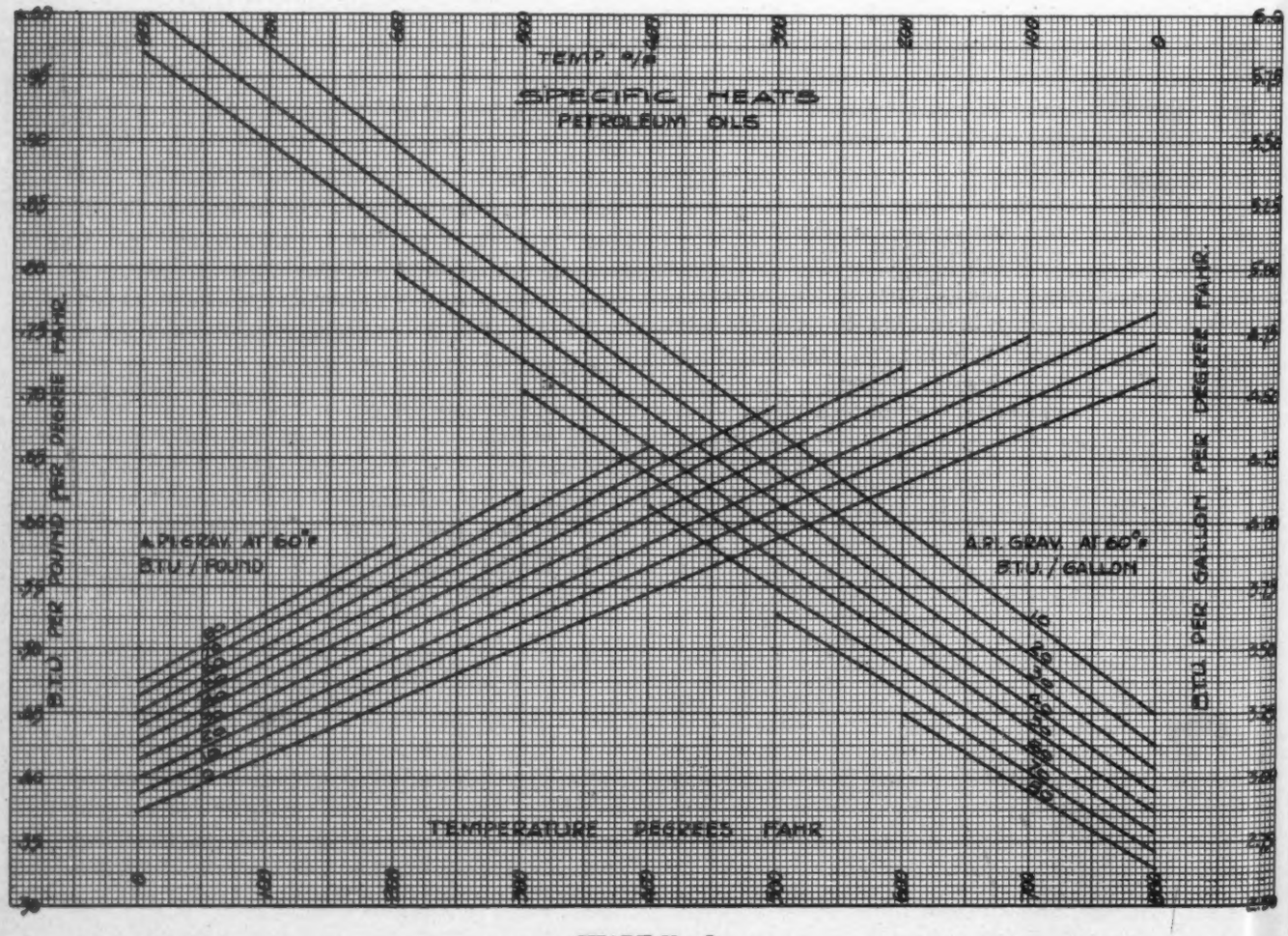


CHART No. 1

THE calculating chart or nomograph can be employed to real advantage by the busy executive, refinery manager, or engineer for rapidly solving many of the every day problems of plant design and operation. Such charts as are presented here by C. M. Johnson, Consulting Engineer, Houston, Texas, and which may be photostated to larger and more easily useable size, will be found useful in the determination of the volume of vapors, either under atmospheric or pressure conditions, passing through equipment such as vapor lines, evaporating columns, fractionators and the like, and in determining the volume of flow to insure adequate size of various parts of the equipment. The charts here presented are based on work carried out in the United States Department of Commerce, Bureau of Standards, and presented in tabular form in Miscellaneous Publication Number 97, "Thermal Properties of Petroleum Products."

In future articles of this series Mr. Johnson will discuss the preparation of calculating charts and additional methods of their application to refinery design and operation problems.

Fahrenheit. Chart No. 2 is plotted as an alignment chart to cover the specific heat of petroleum oils.

The specific heat of a substance is defined as the ratio of the heat required to change the temperature of a unit weight of the substance one degree to the heat required to change the temperature one degree.

The data on the specific heat of petroleum oils were calculated from the equation

$$c = \frac{1}{\sqrt{d}}(0.388 + 0.00045t)$$

in which

c—specific heat in Btu per pound per degree Fahr. or calories per gram per degree Cent.
d—specific gravity at 60°/60° Fahr.
t—temperature in degrees Fahr.

The data do not take into account such quantities as latent heat of fusion, latent heat of vaporization and heat of reaction (cracking).

The relation between true specific heat and temperature is linear and the mean specific heat between any two temperatures is equal to the specific heat at the mean temperature.

As an example, suppose we find the true specific heat of a 20 degree A.P.I. petroleum oil first at 150° F. and secondly at 500°F. Following up from the lower scale at 150 and 500 temperatures on chart No. 1 to the 20 gravity diagonal we read on the left vertical scale values of 0.47 and 0.63. The arithmetic mean value being 0.55 or taking a mean temperature of 150—500/2 or 325°F. We find a value of 0.55 on

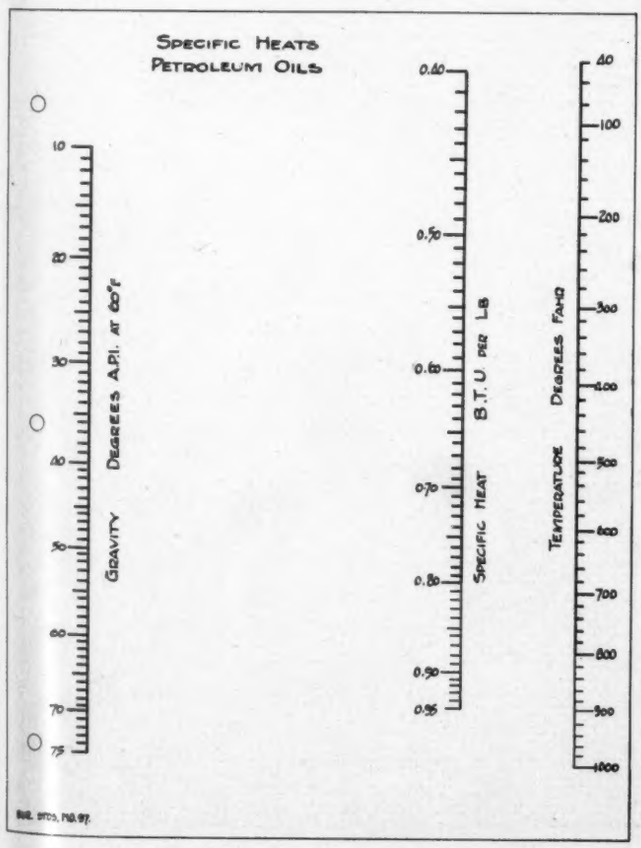


CHART No. 2

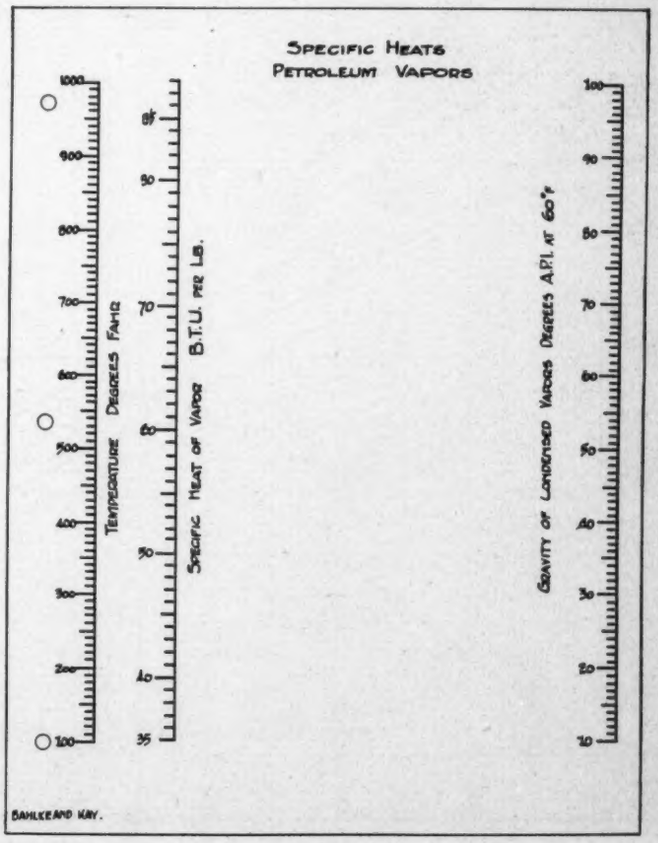

SPECIFIC HEATS
PETROLEUM VAPORS
TEMPERATURE DEGREES FAHR
SPECIFIC HEAT OF VAPOR B.T.U. PER LB.
GRAVITY OF CONDENSED VAPORS DEGREES A.P.I. AT 60°F
BAHLKEAND MAY.

CHART No. 3

the chart. From the alignment chart No. 2 we find values of 0.472 and 0.634 with a mean value of 0.552 which would indicate the value of this type of chart for closer readings.

Inasmuch as nearly all thermo-dynamical calculations are made on the pound of material basis, no mention is made here of the specific heat values in Btu per gallon but the use of this part of chart No. 1 is obvious.

Chart No. 3 is plotted as an alignment chart covering the specific heat of petroleum vapors in Btu per pound per degree Fahrenheit.

The data on the specific heat of petroleum vapors were calculated from the approximate relation:

$$\frac{dL}{dt} = C_g - C_l$$

L —latent heat of vaporization.

t —temperature in degrees fahrenheit.

C_g—specific heat of gaseous phase.

C_l—specific heat of liquid phase.

All at constant moderate pressures.

$$L = \frac{1}{d}(110.9 - 0.09t) \qquad \text{where}$$

d —specific gravity at 60°/60° fahr. of liquid corresponding to condensed vapor.

Evaluating the rate of change of latent heat of vaporation with temperature we have

$$C_g = C_l - \frac{0.09}{d}$$

Balke and Kay in Industrial and Engineering Chemistry 21, page 942, 1929, use the formulae

$C_v = 0.289 + 0.0009\,G + 0.0005\,t$ where

C_v—specific heat at atmospheric pressure.

G —gravity degrees A.P.I. at 60°F.

t —temperature in degrees fahr.

Results from these formulae are in close agreement.

Chart No. 4 is plotted on rectangular co-ordinates and No 5 as an alignment nomograph to cover the latent heat of vaporization of petroleum oils of various gravities in Btu. per pound.

The heat of vaporization may be divided into two values, latent and total. Latent is defined as that quantity of heat which is necessary for the conversion of a unit of liquid into vapor at the same temperature at normal atmospheric pressure. Total heat of vaporization signifies the quantity of heat necessary to convert a unit of the liquid from the constant temperature into vapor at the boiling temperature of the liquid. It is therefore the sum of the latent heat plus the sensible heat required to raise the liquid

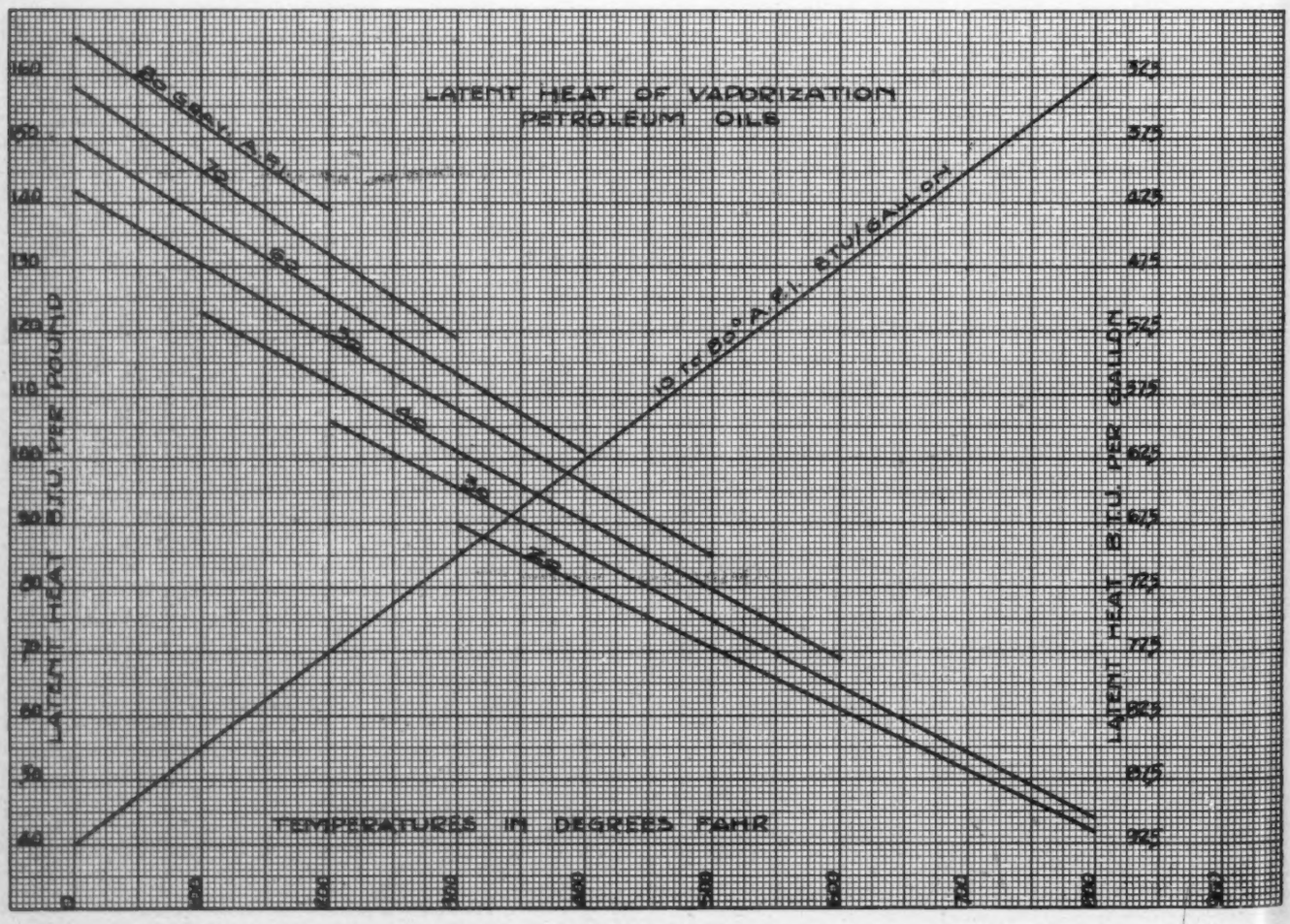

LATENT HEAT OF VAPORIZATION
PETROLEUM OILS
LATENT HEAT BTU PER POUND
LATENT HEAT BTU PER GALLON
TEMPERATURES IN DEGREES FAHR
0 to 80° A.P.I. BTU/GALLON

CHART No. 4

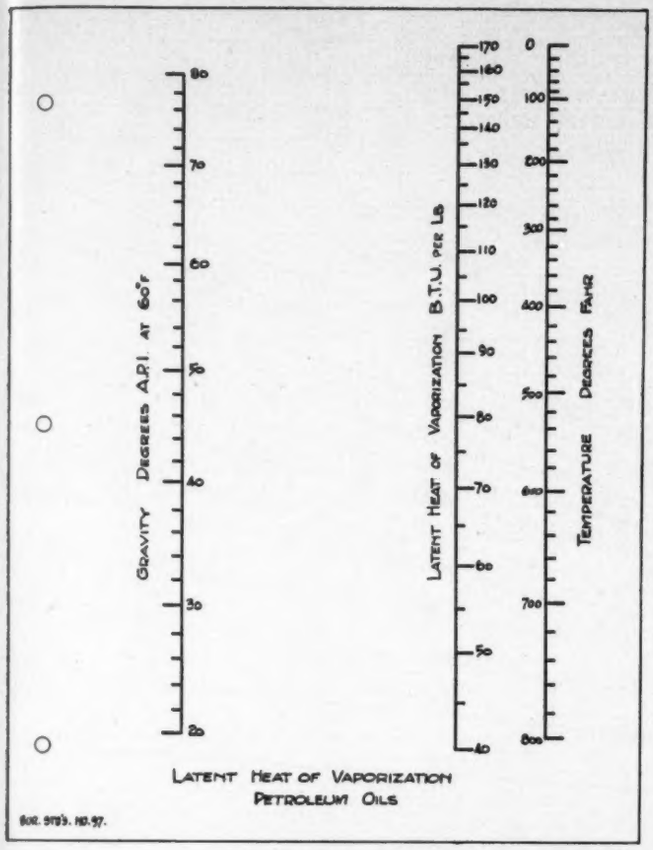

Gravity Degrees A.P.I. at 60°F
Latent Heat of Vaporization B.T.U. per Lb
Temperature Degrees Fahr
Latent Heat of Vaporization
Petroleum Oils
Bur. Stds. No. 97.

CHART No. 5

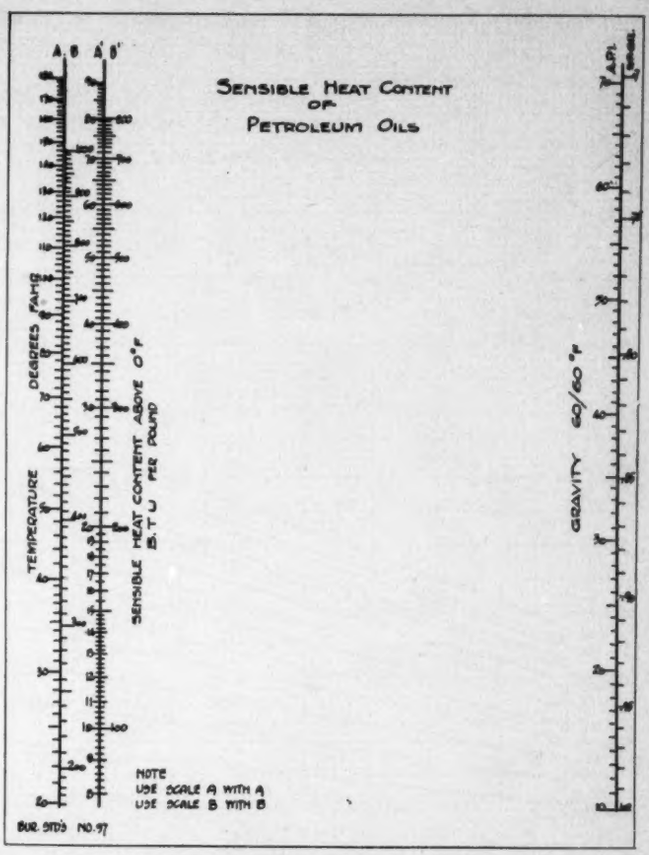


CHART No. 6

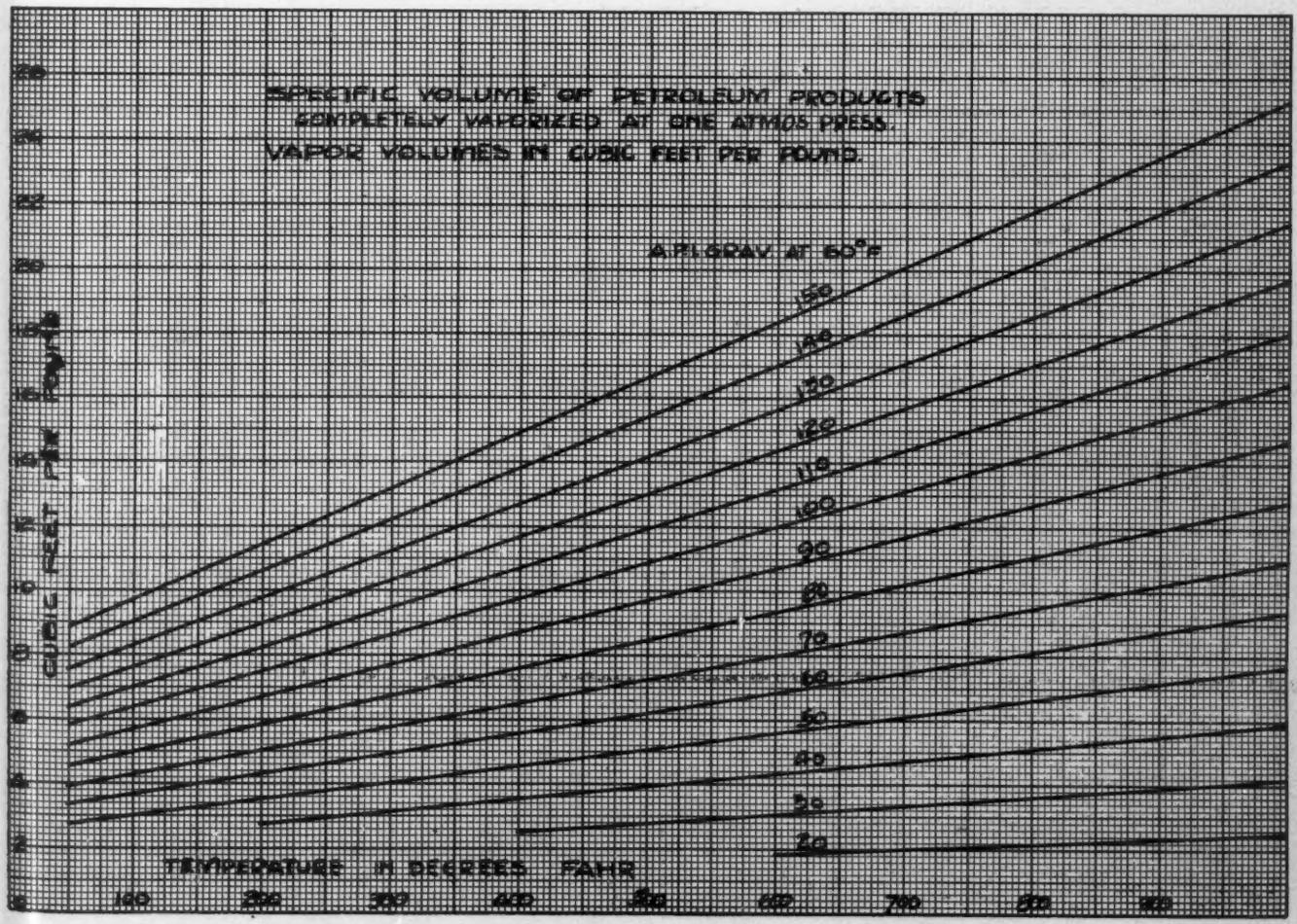

Specific Volume of Petroleum Products
Completely Vaporized at One Atmos. Press.
Vapor Volumes in Cubic Feet per Pound
A.P.I. Grav. at 60°F
Cubic Feet per Pound
Temperature in Degrees Fahr

CHART No. 7

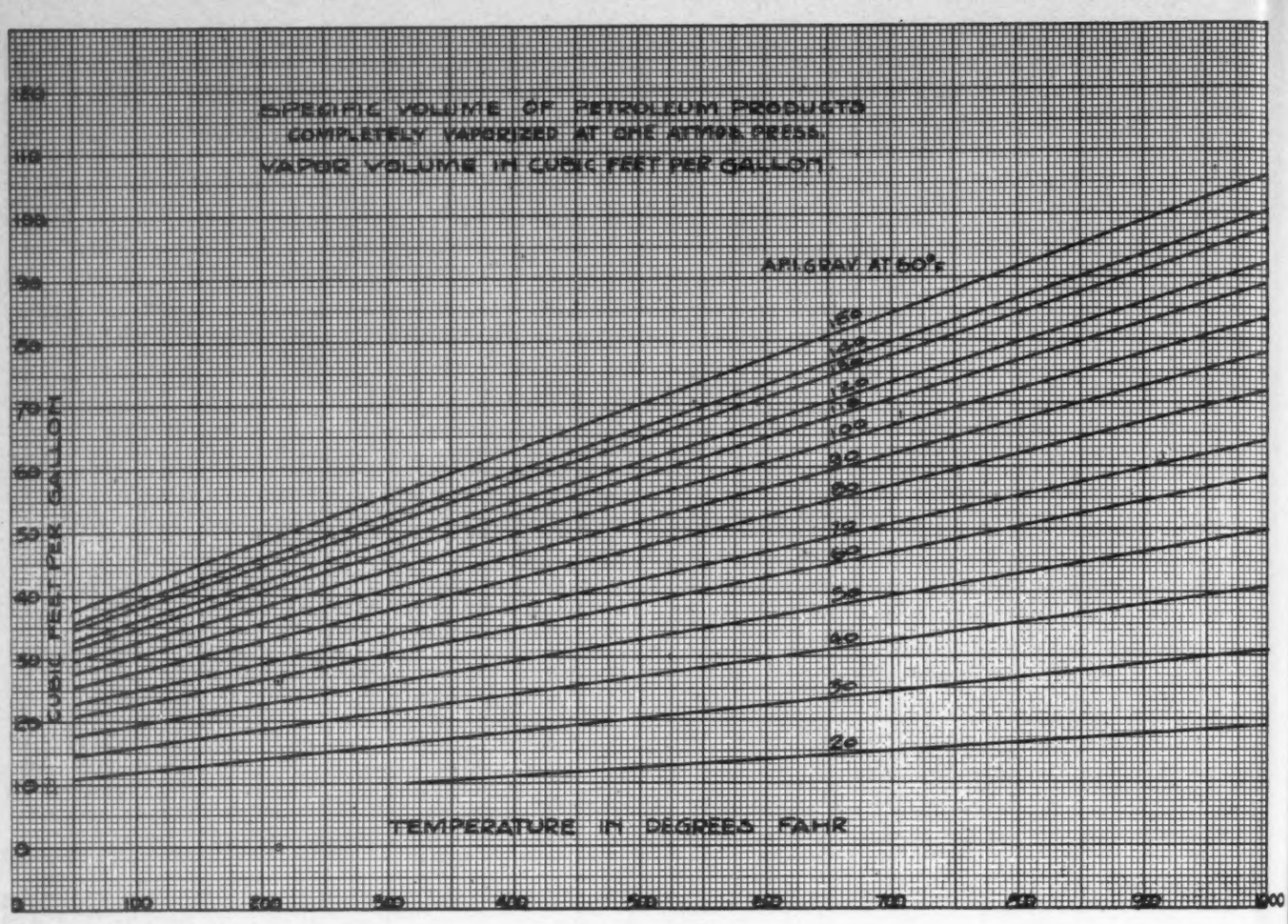

SPECIFIC VOLUME OF PETROLEUM PRODUCTS
COMPLETELY VAPORIZED AT ONE ATMOS. PRESS.
VAPOR VOLUME IN CUBIC FEET PER GALLON
API GRAV AT 60° F.
CUBIC FEET PER GALLON
TEMPERATURE IN DEGREES FAHR

CHART No. 8

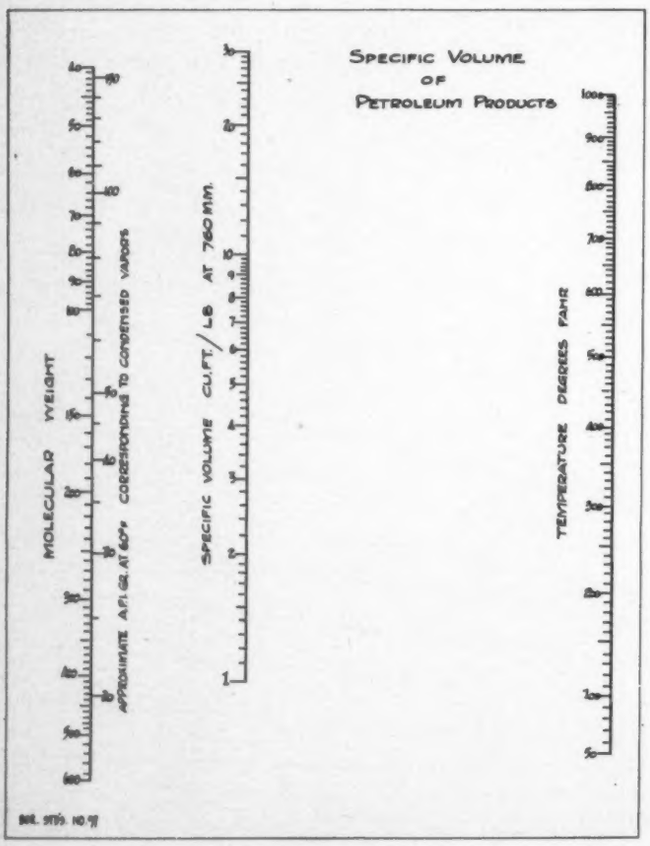


CHART No. 9

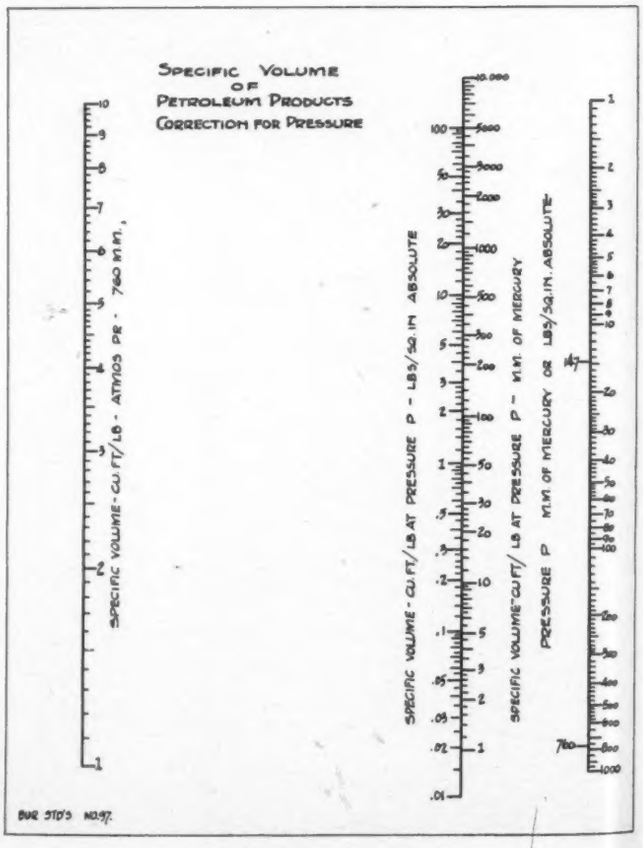

Specific Volume
of
Petroleum Products
Correction for Pressure
SPECIFIC VOLUME-CU.FT./LB - ATMOS PR - 760 M.M.
SPECIFIC VOLUME - CU.FT./LB AT PRESSURE P - LBS/SQ.IN. ABSOLUTE
SPECIFIC VOLUME-CU.FT./LB AT PRESSURE P - M.M. OF MERCURY
PRESSURE P M.M. OF MERCURY OR LBS/SQ.IN. ABSOLUTE

CHART No. 10

from the constant temperature (usually 60°F.) up to its boiling temperature.

The data on the latent heat of vaporization were calculated from the equation

$$L = \frac{1}{d}(110.9 - 0.09t) \qquad \text{where}$$

L—latent heat of vaporization in Btu. per pound.
d—specific gravity of liquid at 60°/60° fahr., and
t—temperature in degrees fahr.

An example of the use of these charts would be for the design of equipment for condensing of hydrocarbon vapors and when combined with Chart No. 1 giving the sensible heat for cooling of the liquid in question gives the total heat to be absorbed for condensing and cooling surface.

Chart No. 6 is plotted as an alignment chart covering the heat content of petroleum liquids in Btu. per pound above 0°F. at atmospheric pressure.

Following usual practice, the heat content of liquid has been arbitrarily assigned the value zero at 32°F. and for practical purposes the heat content of petroleum liquids is given by the equation

$$H_1 = \int_{32}^{t} c\,dt$$

Integrating the equation for specific heat $c = \frac{1}{\sqrt{d}}(0.388 + 0.00045\,t)$ and multiplying by 8.33722d to reduce to a volume basis gives the following equation for heat content in Btu. per gallon above 32°F.

$H_1 = \sqrt{d}\,(3.235t + 0.0001875t^2 - 105.5)$ or, in Btu. per pound above zero degrees fahr. equals

$$H_1 = \frac{1}{\sqrt{d}}(0.388t + 0.000225t^2) + C \qquad \text{where}$$

c—specific heat in Btu. per pound per degrees fahr.
d—specific gravity at 60°/60° fahr.
t—temperature in degrees fahr.
H_1—heat content of petroleum liquids.

For example—How much heat is required to raise the temperature of a 20 degree A.P.I. oil from 150°F. to 500°F. A line drawn from the 20 degree A.P.I. point to the 150 and 500°F. points crosses the heat content line at 74.5 and 259.5 respectively. The difference, or 185, represents the heat required to raise one pound of 20 degree A.P.I. oil from 150°F. to 500°F.

Charts Nos. 7 and 8 are plotted on rectangular coordinates representing the specific volumes of petroleum products completely vaporized at atmospheric pressure in units of cubic feet per pound and per gallon. Chart No. 9 represents in alignment form the specific volume of petroleum products in cubic feet per pound while chart No. 10 takes into account a pressure condition and gives the readings in cubic feet per pound at operating pressure.

The data for these charts were calculated from the equation $pvm = RT$ where

p—one standard atmosphere.
v—specific volume.
R—0.7303.
T—temperature in degrees fahr. plus 460.
m—molecular weight $M = 1.03\,(v - 43) = \frac{44.29d}{1.03 - d}$

in which v = molecular volume of the liquid at 60°F. and d = specific gravity of the liquid at 60°/60° F.

The specific volume V_p at any desired temperature and pressure were calculated from

$$V_p = \frac{760V}{p\ (\text{m.m. of } H_g)} \quad \text{or} \quad V_p = \frac{14.7V}{p\ (\text{lbs./sq. in. abs.})}$$

These charts will be found useful to determine the volume of vapors, either under atmospheric or pressure conditions, passing through equipment—vapor lines, evaporating columns, fractionators, etc.—to determine the velocity of flow to insure adequate size of equipment.

PLATFORMS *and* Safety

PERMANENT platforms on refinery installations, instead of poorly constructed steps and gangways, usually prove good investments. In many of the older plants there has been a complete lack of any code as to standards and to safety. Passages so crooked and narrow that only those well acquainted with the layout have a chance to escape in time of danger, were once prevalent. Modern installations consider ease of operation and safety of primary importance. Platforms around all suspended equipment add to better performance and to safety.

The platform where the operator is found on duty should be of sufficient dimensions and so located that he can have full view of everything that requires his attention. The more manipulations are centralized at this point the better, as decentralized operation is largely responsible for the human error. The extreme of this condition is demonstrated for instance by the placing of a valve on top of a 40-foot suspended condenser, as shown in Figure 1. Obviously the designer did not consider this one valve sufficiently important to justify a platform and a regular stairway or ladder, nor did he give consideration to the fact that the condenser would ultimately need repair or cleaning—and that scaffolding would have to be erected for this purpose.

The most accidents, however, befall those who are ordered to do the repairing of suspended equipment. In one large refinery, for example, there existed a group of 120 condenser and heat exchangers and this plant was burdened with serious repair troubles. Cooling water and crude oil were highly corrosive and no tube lived longer than 90 to 100 days. The result was that every day two or three exchangers were down for partial retubing. A gang of carpenters was constantly building and removing scaffolds so the boilermakers would be able to put in new tubes. This could have been avoided if permanent structures of steel had been installed at the time of erection of the stills. Arrangement for hoisting, such as a trolley and a trolley beam should have been added, enabling the repair crew to do the work in the shortest time, thus reducing the "down-time" for the heat exchangers. Shorter repair periods would have soon offset the cost of permanent steel platforms.

A sketch of a group of suspended heat exchanger is shown in Figure 2. Nothing, in this case, is done to provide for safe operation nor for repair accomodation. In case a few tubes have to be replaced a scaffold must be erected. Figure 3 shows the same installation with proper platforms, stairways, emergency ladder and hoisting facilities. A regular stairway and an emergency ladder at opposite sides are advisable and will add to the safety and confidence of the operator. A cage around the ladder increases its usefulness as a safety device. Many of the larger companies have standardized on the subject of platforms of the type shown in Figure 3, securing the results of cheaper repairs, less days out of operation and fewer accidents.

Another standardization trend is noted in connection with large storage tanks which are being provided with iron platforms and railings around gauge hatches and breather valves. A simple railing along

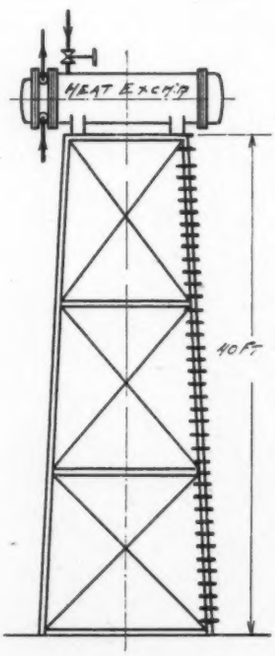


FIGURE 1

Dangerous Heat Exchanger Support. Note absence of facilities for operation or safety

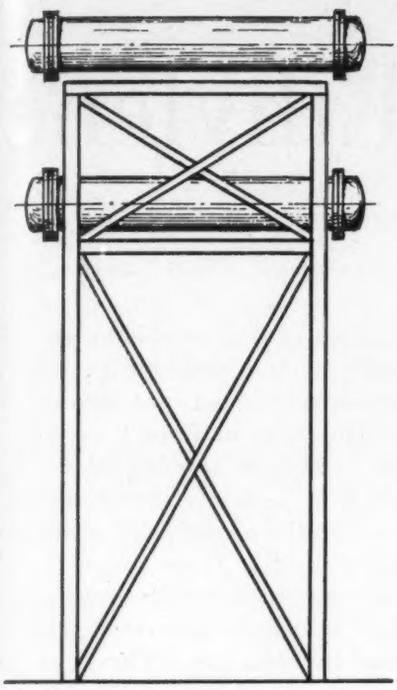


FIGURE 2

Showing usual way of suspending heat exchangers, condensers, etc.

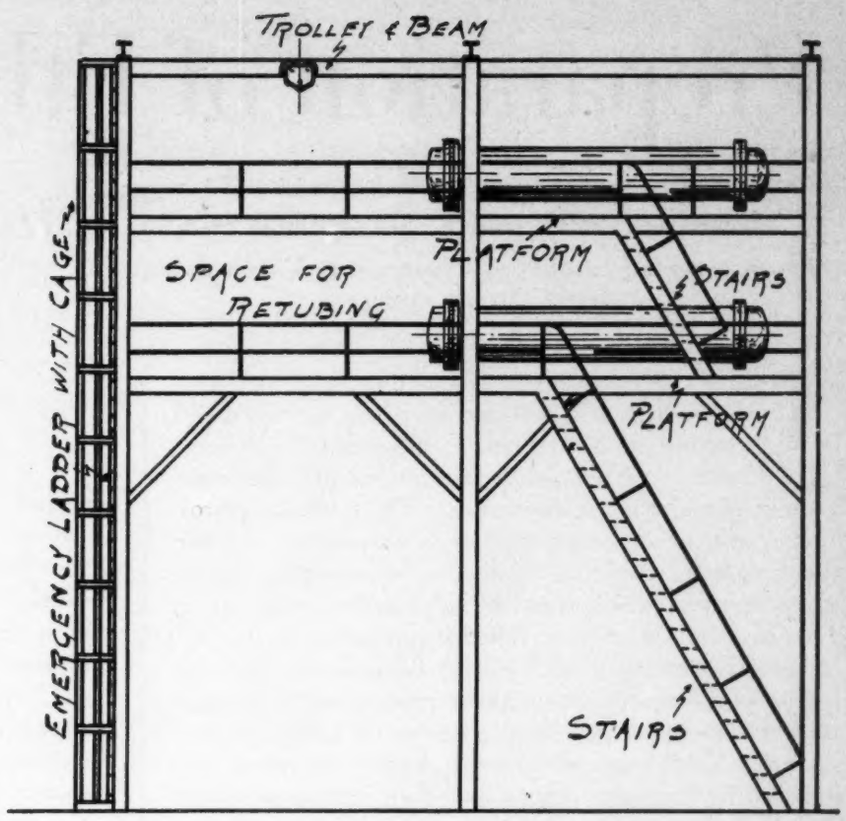


FIGURE 3

Showing better way of supporting same apparatus as Figure 2. Note facilities for operations, repair and safety.

the edge of the tank as shown in Figure 4, also around the hatches and flame arresters, can do much toward the protection of those whose duty it is to gauge tanks and to inspect the safety devices.

Usually it is recognized by refining companies that employment of a high type of workman is necessary if the utmost in safety in plant operations is to be realized. Some companies go further and carefully school such employes under the tutorship of competent instructors, such schooling covering every phase of process operation and maintenance.

In order to provide the maximum in safety in any given process it is advisable to make a detailed inspection of each unit, to develop a flow chart in detail and familiarize each man in all operating and maintenance crews with the complete working of the plant, and to analyze and definitely establish the best method of operation.

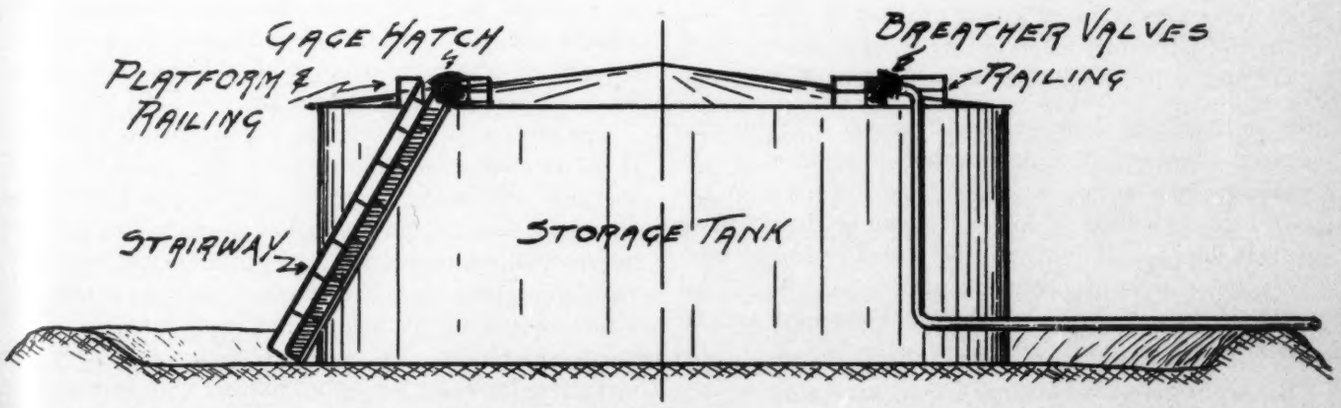


FIGURE 4

Showing stairs, platform and railing for storage tanks.

Preparation of Ethyl Alcohol *from* Ethylene

V. GERR, O. PIPIK and E. MEZHEBOVSKAYA

From Azerbaidzhanskoe Neftyanoe Khozyaistvo: 1932, No. 2, 15-21.

IN this series of two articles information is presented dealing with the preparation of ethyl alcohol from petroleum gases both in the laboratory and one a semi-commercial scale. Ethylene was separated from the homologs by making use of the selective absorption ability of activated charcoal, and separated in the form of ethyl sulphuric acid and the alcohol separated by hydrolysys. Silver and iron catalysts were used to accelerate the reaction. The constants of the synthetic alcohol coincide with those of fermentation alcohol.

Translation is by A. A. Boehtlingk.

THE problem of the utilization of the synthetic petroleum gas has become at the present time very acute because of the great development of vapor and liquid phase cracking industries. The synthetic petroleum gas which is produced as a by-product, is used as fuel in spite of the fact that it contains unsaturated hydrocarbons which could be used as raw material in the preparation of very valuable products. A gas obtained as the result of a normal liquid phase cracking process contains 12 to 14 per cent ethylene, while gas from vapor phase cracking contains 14 to 18 per cent ethylene and a gas obtained in special equipment designed by Professor Buisov has even 20 and more per cent ethylene.

Moreover this gas contains other unsaturated hydrocarbons of the olefine-, di-olefine-, etc., type.

Ethylene may be converted to ethyl alcohol by absorption with sulfuric acid followed by hydrolysis of the ethyl sulfuric acid[1]. This absorption, however, proceeds with some difficulties, it is necessary to use a catalyst at elevated temperatures and a large contact surface between the gas and the acid is required.

During the attempt to prepare ethyl alcohol from the cracked gas, in addition to encountering difficulties specified above, additional difficulties, consisting in the separation of ethylene from its homologs, i.e., from other members of the olefine series, as well as from other unsaturated compounds present in the gas, were met. The customary method of purifying ethylene from its homologs consists in washing the gas mixture with 90 per cent sulfuric acid which absorbs ethylene homologs and leaves ethylene almost unaffected.

In the laboratory experiments carried out by V. F. Gerr and S. N. Popov[2], it was proposed to substitute (1927.)
the sulfuric acid with activated charcoal. The characteristic advantages of this method are the ease with which the carbon may be regenerated and the more satisfactory separation of ethylene from its homologs as well as the possibility of utilizing these homologs; moreover, the useless expenses for sulfuric acid is avoided.

These experiments were therefore resumed and the investigation was carried out in more detail and the results obtained in this laboratory investigation were utilized in a semi-manufacturing scale plant now in the process of erection. All this was undertaken for the purpose of obtaining synthetic alcohols from petroleum gas.

In our first experiments the gas at our disposal contained unsaturated hydrocarbon up to 40 and even 45 per cent, as determined by absorption with sulfuric acid. This highly unsaturated gas is obtained in the manufacture of anti-knock gasoline under special conditions. Later, the composition of this gas changed considerably and the content of unsaturates decreased to 30 to 32 per cent, because gas obtained from the toluene plant had to be used. The greater part of our experiment was carried out with this gas (containing 30 to 32 per cent unsaturates.)

The theoretical basis for the use of activated charcoal is its selective adsorption of gas[3]. If a great excess of charcoal is present, the entire gas mixture is adsorbed first and then the gas with the lower vapor pressure begins to displace gas with the higher vapor pressure. Saturated gases leave the charcoal first, while the unsaturated gases with double and triple bonds are held more tenaciously. Ethylene, the first member of the olefine series, must leave the charcoal with greater ease than its homologs as indicated in the article by Gerr and Popov[4].

For the purpose of confirming this assumption the

[1]Patent of Glood and Schneider: Cf. Ber. :57B, 254-5 (1924); Chem. Abstr. :18, 2125 (1924.)
[2]Neftyanoe Khozyaistvo :10, 88-92 (1926); Chem. Abstr. :21, 2788
[3]P. W. Hill. Petroleum World (Los Angeles) :14, No. 1, 101, 110-1 (1921); Chem. Abstr. :23, 2285 (1929.)
[4]Neftyanoe Khozyaistvo :10, 88-92 (1926); Chem. Abstr. :21, 2788 (1927.)

gas was passed through charcoal and the exit gas was analyzed. An illustration of such analysis is given below. Small portions of gas were passed through 55 grams of charcoal and the exit gas was analyzed.

EXPERIMENT 1

Gas From Vapor Phase Cracking

Liters of gas passed through charcoal	Analysis of the exit gas. Per cent heavy hydrocarbons
15	0.2
30	7.0
40	26.4
55	...
80	25.6
100	26.4
150	26.0
200	33.0
275	35.6
315	35.4
400	36.6
455	37.4
Gas from the line	40.6

EXPERIMENT 2

Gas From Liquid Phase Cracking

Liters of gas passed through charcoal	Analysis of the exit gas. Percent heavy hydrocarbons
0-0	0.0
10-20	0.6
30-40	0.6
40-50	0.6
50-60	1.6
60-70	14.0
70-80	16.4
80-90	23.4
90-100	24.0
100-110	24.2
190-200	21.8
300-310	24.8
360-370	29.0
Gas from the line	30.0

As may be seen from these experiments, the proportion of heavy hydrocarbons changes continuously; the first portions of the exit gas do not contain any heavy hydrocarbons, then heavy hydrocarbons appear in small amounts, their proportion increasing, as the total amount of gas gassing through the charcoal is increased, first to a considerable extent, and then with a certain amount of regularity. Small quantities of heavy hydrocarbons are very tenaciously held by the charcoal.

The adsorption of heavy hydrocarbons by charcoal naturally affects the calorific value of the gas. Its calorific value was determined in a Junkers calorimeter with the results given in the table below.

Through 600 grams of charcoal were passed vapor-phase cracked gases and the calorific value of so treated gas collected in batches was determined. The results of this determination are given in table I.

TABLE I

0 to 60 liters	from 10,609 to 11,370 calories
60 to 120 liters	from 11,039 to 11,800 calories
135 to 190 liters	from 12,439 to 13,200 calories
230 to 290 liters	from 12,539 to 13,300 calories
320 to 380 liters	from 12,670 to 13,460 calories
Gas from the line	13,660

Simultaneously with the change in the quantity of heavy hydrocarbons there was a change in the qualitative composition of the gas discharged through the charcoal. This is very important from the point of view of separating gaseous mixtures[5].

[5]O. Kausch. "Die aktive Kohle."

The qualitative composition of unsaturated hydrocarbons discharged through the charcoal was carried out by means of bromination of the gas and determining the freezing and boiling points of these bromides. Their constants were compared with those obtained by brominating gas which was not passed through the charcoal.

The aforesaid is illustrated by the following few experiments. 1. Thirty-eight liters of gas which was not passed through charcoal were brominated. Thirty-eight grams liquid bromides were obtained. The bromides were fractionated from a Wuertz flask and the following fractions were separated:

133-135°C. .....11.5 grams = 14.6% All fractions
135-140 °C.....40.2 grams = 50.3% do not solid-
140-150 °C.....18.5 grams = 23.3% ify at—20°C
150-175 °C..... 8.7 grams = 11%

The distillation was discontinued because of a noticeable decomposition of the high boiling bromides.

II. Fifty liters gas were passed through 200 grams of charcoal. Twenty grams of bromides were obtained, which solidified completely at + 8°C.

III. Seventy-five liters gas were passed through 200 grams charcoal. Ninety-six grams bromides were obtained, solidifying partly at + 3°C. and completely at + 1°C. The bromides were fractionated as follows.

130-132 °C.....36.5 grams = 38.1%
132-133 °C.....43 grams = 45 %
133-135 °C..... 7 grams = 7.3% 90%
135-142 °C..... 3.6 grams = 3.75%

IV. Forty liters gas were passed through 40 grams charcoal. Eighty-two grams of bromides were obtained, which remained liquid at — 10°C. They were fractionated as follows:

130-133 .....38.45 grams = 47 %
133-135 .....29.66 grams = 36.3 % 83%
135-140 ..... 9.7 grams = 11.8 %
140-149 ..... 2.6 grams = 3.18%

Etheylene alone was present in the unsaturated hydrocarbons present in the gas discharged through charcoal after passing 50 liters of gas through 200 grams of charcoal, determined from the freezing points of the bromides. It is evident that all other unsaturated hydrocarbons were retained by the charcoal. When 75 liters of gas were passed through 200 grams of charcoal small quantities of other unsaturated hydrocarbons appeared in the discharged gas. The bromides did not have the freezing point of ethylene dibromide and solidified at + 3 to +1°C. A distillation from the Wuertz flask, however, showed that ethylene predominated in the discharged gas; the fraction boiling below 135°C. contained 90 per cent of all bromides, whereas the gas which was not passed through charcoal contained only 4.6 per cent. When still larger amounts of gas were passed through charcoal (one liter of gas per gram of charcoal) slightly larger amounts of ethylene homologs were detected in the discharged gas. The bromides did not solidify even at — 10°C., although judging by the boiling points, this space velocity was

not so excessive because the fraction boiling below 135°C. constituted 83 per cent of the total bromides. Of course, the distillation in a Wuertz flask is not a sufficient criterion, and it may be used only for an approximate evaluation of the ratio of gas and charcoal. In cases where ethylene is the desired product and other unsaturated hydrocarbons must therefore be removed, only 25 liters of gas should be passed through every 100 grams of charcoal at a velocity of 30 liters per hour.

Due to the selective adsorption of gases by charcoal we succeeded in separating ethylene in highly concentrated form from a gas mixture. The principle of the method consisted in passing the gas through activated charcoal under such conditions that saturated gases and ethylene passed through the charcoal while all other unsaturated gases were retained by the charcoal. This discharged gas was passed through another charcoal adsorber. Of the gases present in this gas mixture containing hydrogen, methane and ethylene only, the latter should be retained in the second adsorber. This assumption was completely confirmed by experiment (Figure 1.)

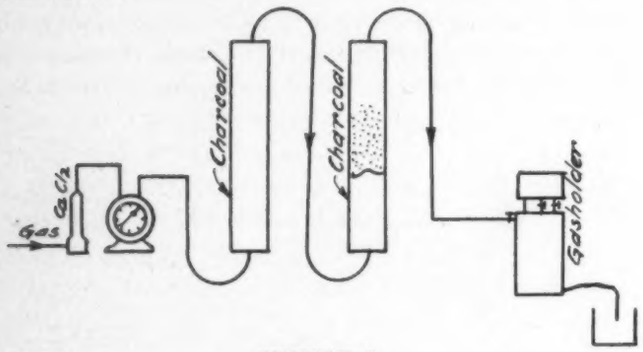


FIGURE 1

The experiment was carried out as follows: two charcoal adsorbers were connected so as to have the gas that passed through the first adsorber enter the second adsorber directly. The gas discharged from the second adsorber was analyzed periodically. The charcoal in the second adsorber was treated with superheated steam after the end of the experiment and the gas was collected in a gas holder. The gas was analyzed by the Orsat method and, moreover, it was brominated and the constants of the bromides were determined.

FIRST EXPERIMENT

Twenty liters of gas were passed through two adsorbers with the object of concentrating the ethylene in the second adsorber. The first adsorber contained 50 grams and the second 200 grams of charcoal. The exit gas from the second adsorber was collected and upon analysis did not show any unsaturated hydrocarbons. From our previous experiments, however, we knew that all unsaturated hydrocarbons except ethylene should have been adsorbed when passing 20 liters of gas through 50 grams of charcoal. Evidently, ethylene, which was not detected in the discharged gas must have been retained in the second adsorber. In the following experiments the proportion of gas was changed because in the first preliminary experiment a great excess of charcoal was used.

SECOND EXPERIMENT

Eighty liters of gas were passed through two adsorbers, each containing 200 grams of charcoal. The discharged gas was collected in a gas holder.

Gas analysis by Orsat.....	CO_2	0.2%
	O_2	3.7%
Heavy hydrocarbons		0.9%

After having proved that on using such proportion of charcoal, only traces of unsaturates are present in the discharged gas from the adsorbers, the gas obtained from the second adsorber by steam distillation was analyzed. This gas contained 62 per cent heavy hydrocarbons. Their bromides had a final boiling point of 134°C. and a freezing point of +5°C. Accordingly, their constants are close to those of ethylene di-bromide. It was found that the concentration of ethylene amounted to 62 per cent and that it was free from its homologs. In some similar experiments the concentration of ethylene reached 70 per cent.

THIRD EXPERIMENT

One hundred liters of gas were passed through three adsorbers at a velocity of 30 liters per hour. The first adsorber contained 200 grams, the second 200 grams and the third also 200 grams of charcoal. The exit gas did not contain any unsaturates. After the experiment was over, the gas distilled off from the second and the third adsorber was analyzed. The second adsorber contained 72 per cent unsaturates (ethylene) and the third 30 per cent ethylene. It thus appears that the ethylene is concentrated mainly in the second adsorber. The third adsorber also contained large amounts of saturated gases. In later experiments the authors succeeded in raising the concentration of ethylene up to 85 to 86 per cent.

Thus the concentration of ethylene can be increased by two methods which may be used in combination, i. e., (1) by adsorbing the ethylene with charcoal on the basis of a certain calculation and (2) by distilling the gas from the charcoal and collecting it in a combination of gas holders. The purity of ethylene is controlled by its bromide constants.

In some cases a separation of ethylene from saturated gases may not be required and it may be sufficient to effect its separation from its higher homologs only. For example, in the preparation of alcohol ethylene is absorbed by sulfuric acid, while the saturated gases, hydrogen and methane are discharged without being absorbed.[6]

This is Glund's method using chemically pure ethylene. Experiments carried out by Gerr and Popov confirmed the possibility of using this method with ethylene diluted with saturated gases but prop-

[6]Monier-Williams. Power Alcohol: Chapter on Synthetic Alcohols.

erly separated from its homologs. Experiments carried out by these authors who brominated gases discharged from the charcoal served as the basis for determining the proper ratio between the gases and the charcoal. To prepare pure ethyl alcohol 25 liters of gas should be passed through each 100 grams of charcoal, since with this ratio of gas to charcoal the bromides of the gas after passing over the charcoal have a freezing point of +8°C. (See Experiment 2; Bromination of Gas), i. e., ethylene di-bromide; under these conditions, however, a fair amount of the ethylene is adsorbed by the charcoal which affects the yield of alcohol. Since our first problem was the preparation of technical alcohol, we passed through the charcoal large amounts of gas, namely 80 liters, through every 100 grams. As may be seen from Experiment 4, when 100 liters of gas were passed through 100 grams of charcoal and the gas brominated the bromides did not freeze; however the ethylene fraction predominated as may be seen from the fractionation. For the technical alcohol we slightly raised the proportion of gas to charcoal, i. e., 80 liters through 100 grams. Our first experiments were carried out in glass apparatus. For the purpose of determining the ratio between the size of the scrubber and the velocity of the gas flow, experiments were carried out in three different scrubbers; the first scrubber had a diameter of 5.2 centimeters and height of 40 centimeters, the second 5.2 centimeters and 82 centimeters and the third 3 centimeters and 144 centimeters respectively. The scrubbers contained glass wool or small broken pieces of glass to increase the contact surface as much as possible. The acid amounting to 300 grams was kept in continuous circulation countercurrently to the gas. The gas after having been dried with calcium chloride was passed through a meter, then through a charcoal adsorber and through the acid scrubber countercurrently to the acid. The alkyl sulfuric acid formed was diluted with water in equal parts by weight and was then hydrolized by boiling and the dilute alcohol distilled off from a sand bath. The strength of the alcohol was determined by means of a Westphal balance and the recalculation to absolute alcohol was carried out by the Mendeleev table for alcohols.

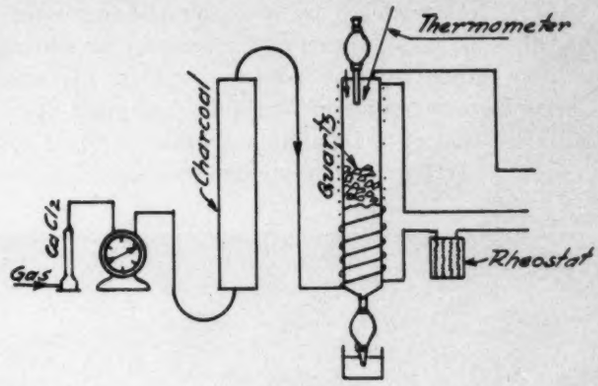


FIGURE 2

In preliminary experiments approximate yields of alcohol, the ratio between the velocity of gas flow and the size of the column were ascertained.

TABLE 1

Amt. of gas in cc.	Amt. of charcoal in grams	Velocity of gas liters per hour	Per cent of heavy hydrocarbons in gas	Yield of alcohol in grams	Size of the column in centimet. Height	Diam.	Vol.
200	250	10	38.5	24	40	5.2	....
200	250	20	38	19.2	40	5.2	....
240	300	40	37	20.2	82	5.2	666.6
320	400	40	33	33	82	5.2	666.6
320	400	40	36	28	82	5.2	666.6
200	250	40	23 to 30	23.8	82	5.2	666.6
200	250	40	31	19.7	82	5.2	666.6
200	250	20	35	22	82	5.2	666.6
300	375	60	..	35	144	3.0	1022.4

Note: Glass wool was used as filler.

All the experiments enumerated in Table 1 were carried out on the same basis: 80 liters of gas were passed through each 100 grams of charcoal at a temperature of 40°C. and in the presence of one per cent silver sulfate dissolved in sulfuric acid (1.84 sp. gr.). In spite of the unsatisfactory condition of the apparatus in the preliminary experiments, which caused some variations of the yields, it should be noted that as far as could be ascertained from the experiments the velocity of the gas flow can be increased proportionally to the height of the column. This fact was made use of when changing the capacity of the apparatus.

Water Treatment of Corrosive Gas

GASOLINE produced by re-compression at Barnsdall Oil Corporation's Earlsboro, Oklahoma, plant, like other gasoline produced in the area, has been corrosive since the beginning of plant operations. The problem in isolating the cause of slight corrosiveness after chemical treatment was solved by experimenting with gases and vapors in various departments of the plant. This investigation showed that if the vapor coming from the horizontal run tank were neutralized or treated before entry into the cylinder of the re-compressor, no difficulty would be experienced in treating the finished stabilized product.

Looking down on hot water treater and run tank in Barnsdall's Earlsboro gasoline plant

The first method of treating these gases consisted of using an extra absorber partially filled with caustic solution of five to six degrees Baume. This absorber was placed near the run tank and convenient to the connections leading to the intake of the re-compressor. About one-third of the absorber shell, vertically, was filled with caustic solution, while the upper two-thirds was used as a knock-back compartment to prevent the passage of liquid over to the intake line. This treatment was sufficient to insure easier treating of the finished product.

Later investigation with fresh water indicated that similar results could be secured through its use, and eliminating the caustic wash. In passing through the water the corrosive hydrogen sulphide was removed, but the water soon became ineffective. The problem then became one of supplying the absorber with a continuous stream of fresh warm water, as a substitute to batch methods.

As a considerable amount of low compression gasoline is manufactured in the gas cooling coils before the gas is introduced into the absorbers, and is off color, a re-run still was placed in operation with a steam heating element in the base. From this element a quantity of hot distilled water is trapped at all times. Knowing that most processes react better when higher temperatures are employed, this condensate is led from the trap to the tower in which caustic solution formerly was used. Only a few pieces of pipe and a few fittings were required to make this connection. The tower is filled one-third with condensate from the heating element and when in the tower, a temperature of 110 to 115° F. is maintained. This maintenance of temperature is accomplished by the automatically dumped water. A drain is placed in the base of the tower from which sedimentation and surplus water is removed.

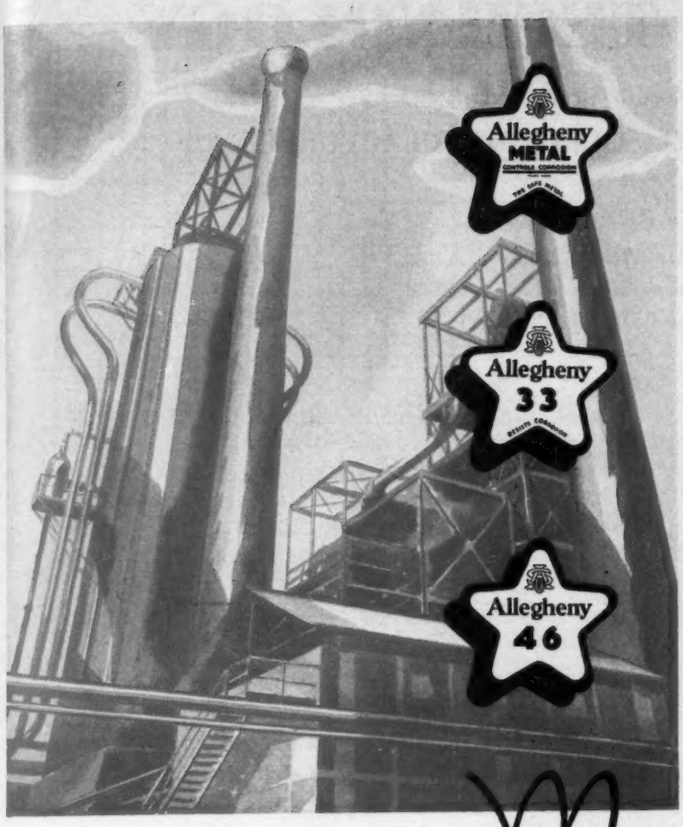
This treatment of this particular gas was successful. No caustic has been used as a pre-wash on this vapor since the first time water was used in its place. On an average of 750,000 cubic feet of gas is handled by the recompressor each day, and all of it is first passed through the warm water pre-wash. When the volume falls to around 500,000 cubic feet, the gasoline in the recompressor accumulator is sweet and non-corrosive, but when the volume climbs to the normal, it becomes a trifle corrosive, but not enough to hinder the finished gasoline from being easily treated. After the first cost of installation, nothing has been spent on the apparatus. The hot water is automatically dumped from the heating element to the tower and the operator merely draws the surplus water from the base of the tower occasionally.

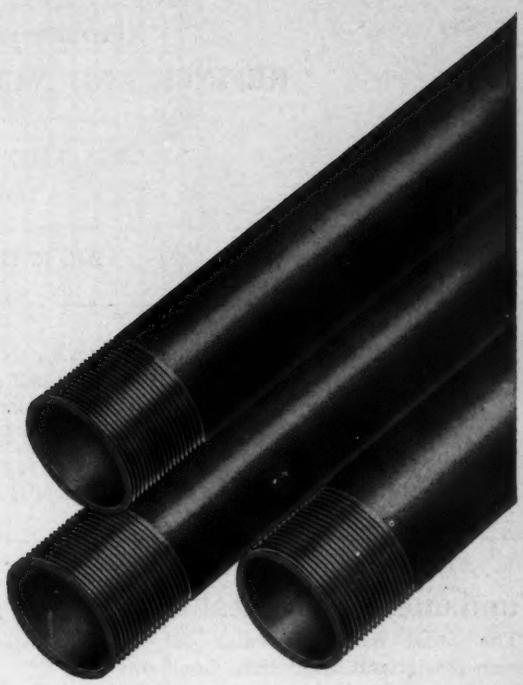
Storage Tank Setting

A COMPARATIVELY new "stunt" in setting gasoline plant storage tanks was apparently originated by the Harmony Gasoline Company near Longview, Texas. In most instances, the setting is a permanent job constructed of concrete and if the plant is dismantled and moved, the tanks are removed and the setting left as so much junk.

But in the case at the Harmony plant, if ever a time comes when the equipment should be moved to another location, the setting may be taken with the tankage and placed on the new site. In constructing this tank battery setting, junk pipe was used throughout the job. Six-inch pipe was used for corner posts and the post for the two center ones. The lower ends were imbedded in a concrete block for rigidity while the upper ends were welded to wide flat straps shaped to fit the under side of the tank. Sufficient bracing, angles from upright posts to tank cradle, lateral or longitudinal pipes were welded from post to post and when completed a setting was provided that is as serviceable as concrete and has the advantage of being semi-portable.

All that is necessary to move the setting is to cut the posts above the concrete bases, hoist on a truck and move to the new location. When ready to reset, new posts, cut in stub length can be set in other concrete blocks and the old setting placed upon them and welded in place.





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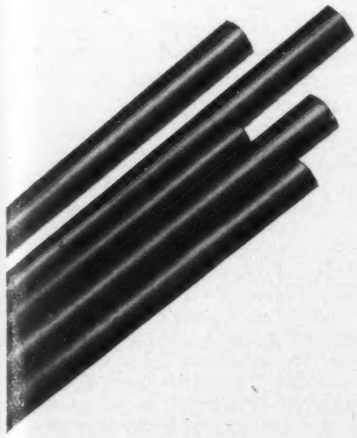

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by

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under the supervision of

DR. E. H. LESLIE and DR. H. B. COATS

The abstracts here presented are selected from the current literature of science and technology to afford reference to fundamental information not easily available to all readers. Abstracts of articles appearing in readily obtainable trade journals are not included.

Photostat copies of original articles will be supplied at cost by the Leslie Laboratories. Complete or limited bibliographies covering special topics by title, by abstract, or in complete manuscript, will also be prepared and furnished at reasonable cost by the Laboratories.

Fundamental Physical Data

The Most Probable Value of the Stefan-Boltzmann Radiation Constant. F. E. HOARE. *Phil. Mag.* **14** (1932) pp. 445-9.

The best value as judged from the present state of knowledge of the subject is $5.742 \pm 0.019 \times 10\text{-}5$ ergs./sq. cm./sec./deg. 4.

Relationship between Mole Fractions and Absolute Viscosities of Blended Lubricating Oils. E. R. EPPERSON AND H. L. DUNLOP. *Ind. Eng. Chem.* **24** (1932) pp. 1369-71.

An effort was made to evolve a satisfactory formula for the calculation of viscosities of lubricating oil blends from a knowledge of the properties of the oils blended. To this end the molecular weights of several lubricating oils were determined. The equation of Kendall and Monroe, $n^{1/3} = X\, n_1^{1/3} + (1 - X)\, n_2^{1/3}$ in which n is the absolute viscosity of the blend, n_1 and n_2 the absolute viscosities of the components, and X is the mole fraction of one component, was found to hold with a maximum division of 3 per cent.

Specific Heat of Gases at High Temperatures. W. T. DAVID. *Nature* **129** (1932) p. 942.

Combustion is far from completed at the instant of maximum pressure in explosions of gases in closed vessels. Hence, the values determined by the explosion method for gases at high temperatures are higher than the true values.

Chemical Composition and Reactions

Catalytic Vapor-Phase Hydration of 2-Butene Under High Pressure. L. F. MARCK AND R. K. FLEGE. *Ind. Eng. Chem.* **24** (1932) pp. 1428-31.

Catalytic vapor-phase hydration of 2-butane at 427°- 538°C under condition of continuous flow and at pressures of 3000 to 5000 lb. per sq. in. results in the formation of 2-butanol. However, the yields are low. As the mole ratio of steam to butane is increased the conversion to the alcohol or hydrated products increases and formation of polymers decreases. Pressure increase from 3000 to 5000 lb. affects polymerization more than hydration. Catalysts, such as phosphoric acid and cuprous chloride supported on pumice, promote hydration at temperatures between 400°C and 550°C.

The Combustion of Hydrocarbons. W. A. BONE. *Proc. Roy. Soc.* (London) **A 137** (1932) pp. 243-74.

Both slow and explosive combustion of hydrocarbons begins with addition of oxygen but whether by hydroxylation or by peroxidation has been questioned. Evidence for hydroxylation is found in the isolation of the hydroxylated compounds, in kinetic studies indicating monohydroxylation, and in the characteristic phenomena of explosive combustion that can be explained by hydroxylation but not by peroxidation. Evidence in favor of peroxidation is doubtful. Peroxidation may explain "knocking" as an abnormal feature of combustion, but does not explain the normal course of oxidation. Peroxidation of initially formed aldehydes is probable, and of a few hydrocarbons is possible. The induction period of hydrocarbon combustion needs more careful study.

Manufacture: Processes and Plant

Scientific Principles of Petroleum Technology. L. GURWITSCH. *Chem. and Industry* **51** (1932) p. 984.

A review of the new and revised English translation of Dr. Gurwitsch's well known book. Approximately 100 pages of new matter have been added. The result is a much better balance of context as between European and American experience. The book is divided into four sections dealing with the components of petroleum, manufacturing processes, refining methods, and petroleum products. The book is well made and printed.

Heat Transmission from Metal Surfaces to Boiling Liquids. I. Effect of Physical Properties of Boiling Liquid on Liquid Film Coefficient. D. S. CRYDER AND E. R. GILLILAND. *Ind. Eng. Chem.* **24** (1932) pp. 1382-87.

Direct measurements of boiling-liquid film coefficients were made using an experimental evaporator comprising an electrically heated brass tube suspended in the boiling liquid. By use of thermocouples the temperature of the liquid and pipe were measured at widely varying temperature differences for each of eleven liquids. Dimensionally sound equations were developed that correlated the heat transmission coefficients so obtained with the physical properties of the boiling liquids. The liquids studied were gasoline, kerosene, methyl-alcohol, butyl-alcohol, carbon tetrachloride, and water solutions of salt, sucrose, glycerol, and sodium sulfate.

Choosing Pipe Line Sizes for Maximum Economy. M. FUNDER. *Chem. & Met. Eng.* **39** (1932) pp. 602-3.

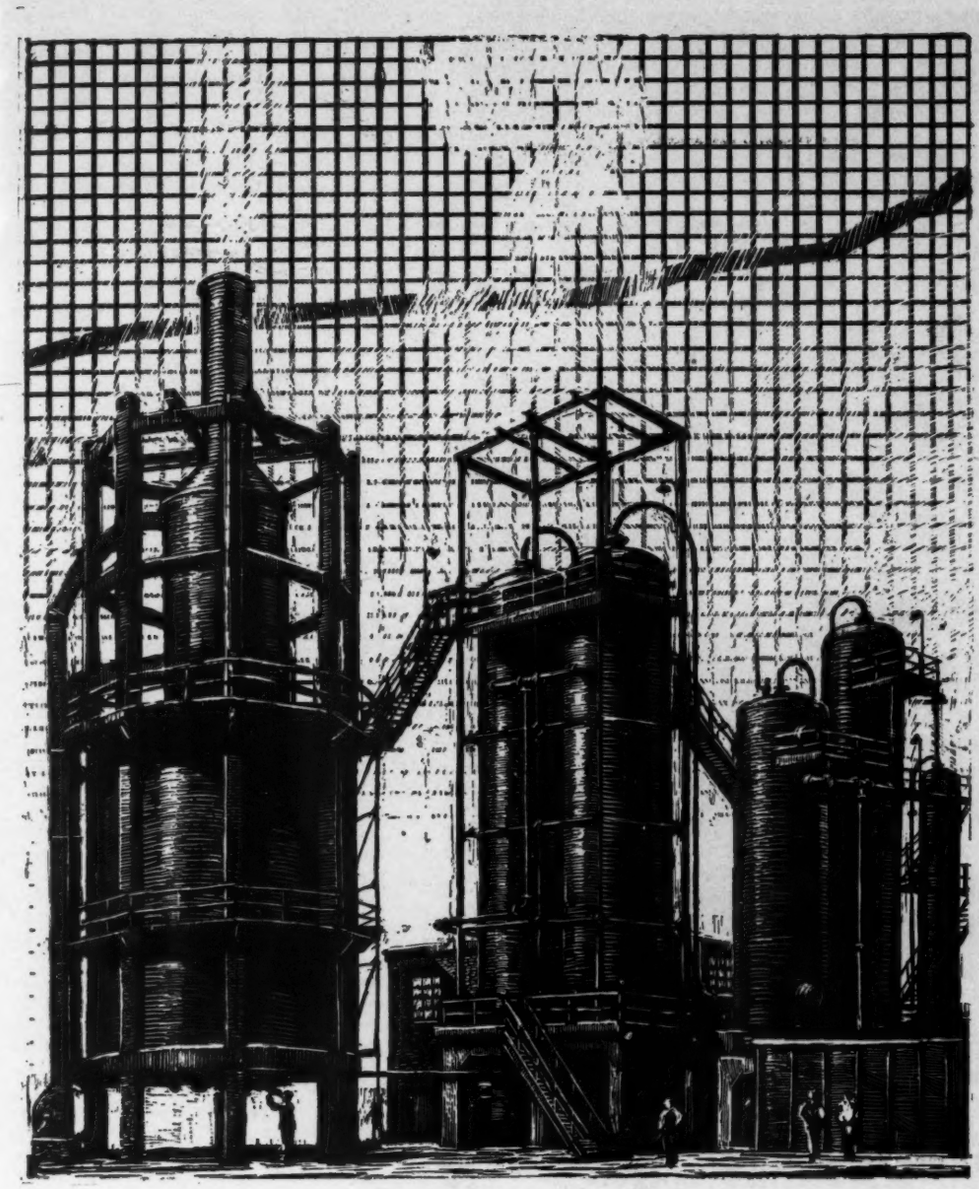
The selection of proper size of pipe for the most economical conveyance of gases and liquids is discussed and illustrated by charts based on chosen assumptions as to cost of pipe installed and on pumping cost.

Evaluation of Bleaching Earths for Mineral Oils. W. SCHAEFER. *Chem. Umschau Fette, Ole Wachse Harze,* **39** (1932) pp. 177-9.

The presence of 4 - 5 per cent of water in bleaching earths is desirable. Anhydrous and also very moist earths tend to darken oils because the sulfo-compounds of treated oils are absorbed most effectively by earth of a definite water content. Traces of caustic soda hinder the bleaching action. Comparative tests, using a standard earth for comparison, constitute the most accurate method of evaluation. An accelerated test for after-darkening of oils involves placing clean iron strips into each of several bottles, filling with the oil, holding in an oven at 60°- 120°C and observing the color after 10, 20 and 30 hours.

Inhibitors in Cracked Gasoline. I. Relation of Structure to Inhibiting Effectiveness. G. EGLOFF, J. C. MORRELL, C. D. LOWRY, AND C. G. DRYER. *Ind. Eng. Chem.* **24** (1932) pp. 1375-82.

The testing of a large number of substances, including phenols, amino- and nitro-phenols, amines, hydrocarbons, halogen compounds, ethers, ketones, quinones, acids, and various nitrogen and sulfur compounds, has demonstrated that many substances increase the induction period of gasoline. A definite relationship has been found between structure and inhibiting effectiveness. The substances found to have pronounced inhibitive properties were these containing phenolic or aromatic amine groupings. However, a single hydroxyl or amine group con-



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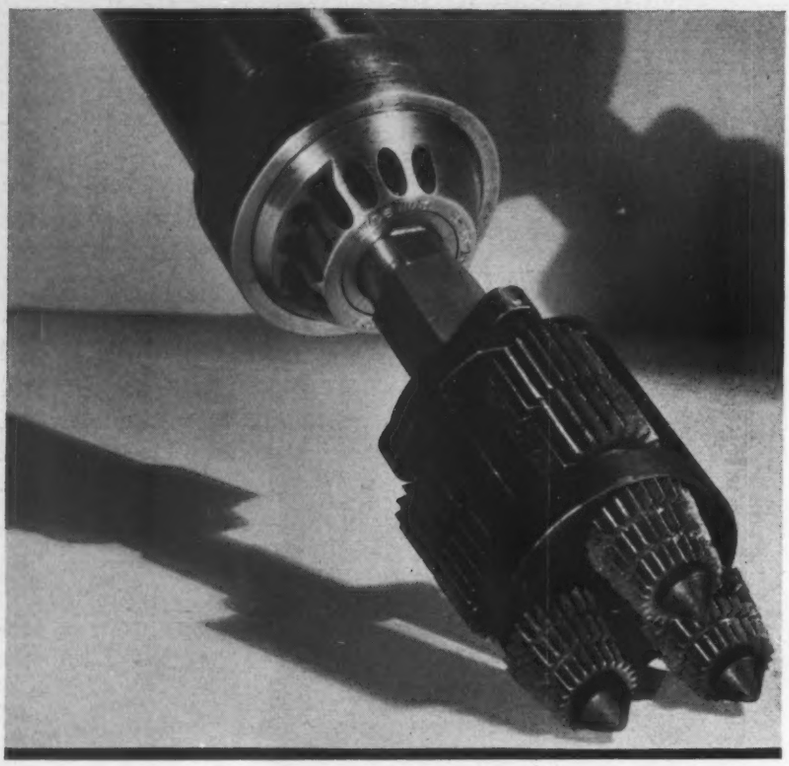

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ferred slight inhibiting properties. The most effective groupings were: more than one hydroxyl or amine group; an aromatic hydroxyl or amine group with one or more alkyl or other modifying groups; an aromatic secondary amine grouping. Modifying groups in amines and phenols were most effective in the ortho and para positions. Inhibitors reduced the amount of gum deposited in the copper dish tests.

The Cracking of Cottonseed Oil. S. EGLOFF AND J. C. MORRELL. *Ind. Eng. Chem.* **24** (1932) pp. 1426.

Cracking cottonseed oil at elevated temperature under pressure yields over 54 per cent of refined gasoline. The oil was cracked by the non-residuum method of operation at a pressure of 135 lb. per sq. in., and over a temperature range of 445° to 485°C. The products of the operation were characterized and the refining of the pressure distillate studied.

Cracking of Manchurian Shale Oil. G. EGLOFF AND E. F. NELSON. *Chem. and Industry* **51** (1932) pp. 326-77.

The flashing method of cracking yields 52.6-55.9 per cent gasoline. The coking method yields 67.5 per cent. The flashing method gives 26.3 to 32.6 per cent residuum in addition to the gasoline.

Hydrogenation of Mineral Oils H. BURSTIN & S. WINKLER. *Erdo. u. Teer* **8** (1932).

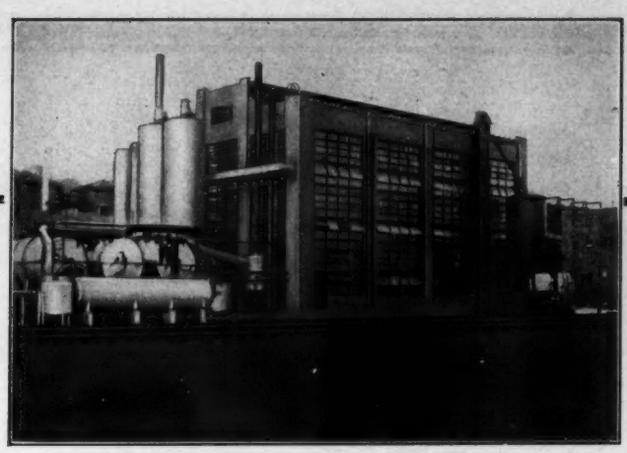
Hydrogenation was effected in a 1-liter Hofer autoclave fitted with a stirrer, and with hydrogen charged at 150 atm. pressure. Optimum temperatures were determined. The pressure in the autoclave during heating was 320 atm. and upon cooling 60-70 atm. Paraffinic gas-oil gave 96.87. liquid products including 3 per cent benzine, and no coke. Cracking alone gave 93.6 per cent liquid products, including 40 per cent benzine, and 3 per cent coke. On rehydrogenation, the residuum from once hydrogenated oil gave almost as much benzine as before, but recycling and much tar. Hydrogenating Schodnica residuum at 440 to 445°C gave 27.5 per cent benzine and 0.8 per cent coke. Bitkow residuum yielded 27.5 per cent benzine and 0.2 per cent coke, and Boryslaw residuum 19.1 per cent benzine and 3.1 per cent coke. The yields of benzine would be much higher in a continuous and recycling process. Schodnica and Bitkow residuum hydrogenate well without a catalyst. Boryslaw residuum probably will require a catalyst to minimize formation of asphaltic substances and coke. Further work will be done in which catalysts will be used.

Refining of Kerosene. W. GROTE AND E. HUNDSDORFER. *Petrol. Zeitsch.* **28** (1932) No. 28 pp. 9-14.

The results of Danaila are criticised and the specifications of kerosene are discussed. Kerosene fractions from Rumanian petroleum were refined by the Edeleanu process and photometrically examined under conditions of maximum height and constant height of flame. Similarly refined fractions were submitted to the smoke test. The data show that the Edeleanu method gives superior burning oils and freedom from soot and objectionable odor during burning is as important as illuminating power.

Hot Water Separation of Bitumen from Alberta Bituminous Sand. K. A. CLARK AND D. S. PASTERNACK. *Ind. Eng. Chem.* **24** (1932) pp. 1410-16.

A method is described for determining the yield of bitumen securable in laboratory-scale hot water separation of bituminous sand. The effect of acidity, alkalinity, and of the presence



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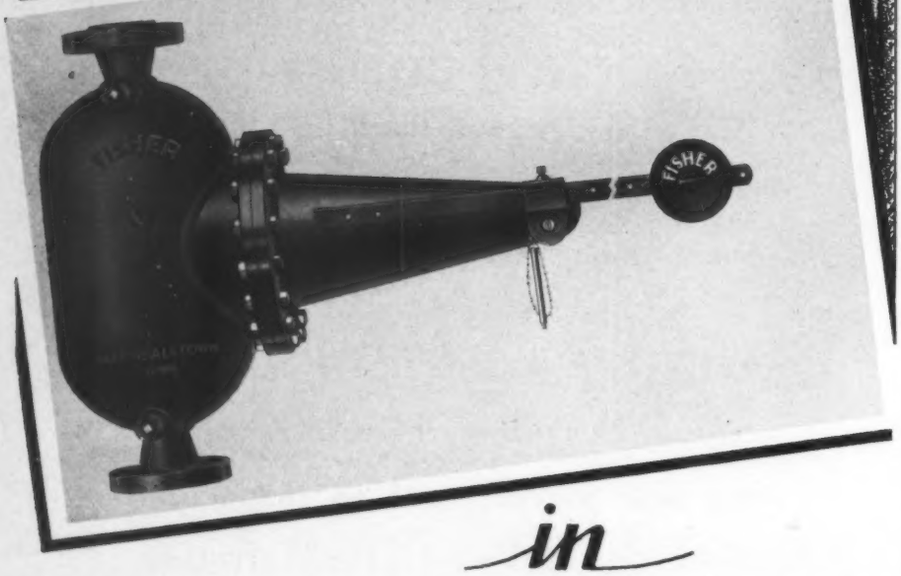

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of various salts on the effectiveness of the separation was studied. The acidity of the sand must be neutralized before washing with hot water is effective. Calcium and magnesium hydroxides are particularly detrimental. Clay exerts an adverse influence and is the most troublesome impurity in the sand from a commercial standpoint.

Designing Heads for Tanks and Heat Exchangers. C. O. SANDSTROM. *Chem. Met. Eng.* **39** (1932) pp. 668-72.

The design of heads for pressure vessels and exchangers is discussed from a theoretical and practical standpoint. Empirical equations and charts are given for design.

Products: Properties, Utilization and Tests

Insecticidal Studies of Mid-Continent Distillates as Bases. HENRY H. RICHARDSON. *Ind. Eng. Chem.* **24** (1932) pp. 1394-7.

Wide variations in the distillation range and gravity of petroleum distillates used as bases for pyrethrum extracts for household sprays was found. An investigation was therefore made to determine which fractions are most efficient for use in the preparation of these bases. Short-cut and long-cut fractions were tested. An Edeleanu extract was also tried. Distillates of boiling range 378-516°F., are most toxic. Shorter cut fractions in the boiling range 398-500°F., are as efficient as those of wider boiling range but not so easily made industrially. The long range distillates that is most toxic was also found to be the most efficient in extracting pyrethrum.

Gravity Index for Lubricating Oils. W. B. MCCLUER AND M. R. FENSKE. *Ind. Eng. Chem.* **24** (1932) pp. 1371-74.

The authors have modified the manner of expressing the viscosity-gravity constant of Hill and Coats so that gravity index numbers similar to the viscosity index numbers of Dean and Davis are calculated. The method was applied to laboratory data on fifty-four oils and to data from the literature on fifty-eight oils. Gravity indexes expressed in this manner correlate fairly well with viscosity indexes. Hydrogenated oils give normal relationships, but oils made synthetically by polymerization of olefines show a difference in these inter-related properties.

The Modern Theories of Lubrication. Oil-Film Lubrication. H. BRILLIE. *Bull. Sec. Belg. Ing. Ind.* (1932) pp. 429-67.

The factors entering into oil film lubrication are discussed. The fundamental equations for variation of pressure in the body of the oil film and for the unit area resistance of the oil film are developed. Formulas for the pressure, resistance, and coefficient of friction in the oil film are given. Mechanical means of creating a continuous oil film on a rotating surface are discussed as well as applications to engines. Test results on several types of machinery are given. The author concludes that oil-film lubrication is more economical than ordinary lubrication, as the passive resistance practically disappears. Estimates of savings on marine engines and railroads are given.

Colloidal Structure of Asphalt. R. WILHELMI. *Erdol u. Teer* **8** (1932) pp.

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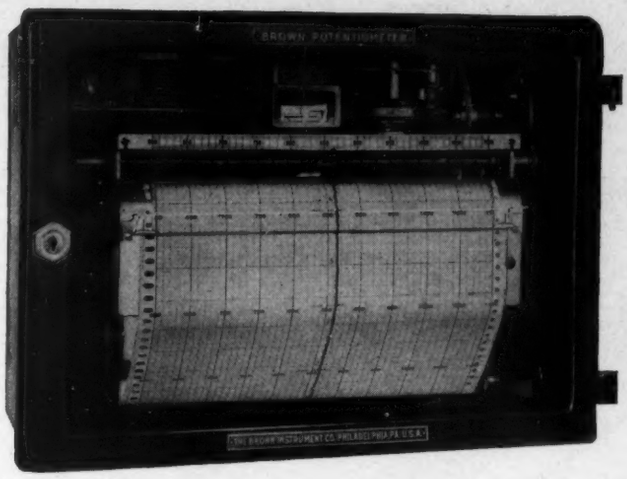

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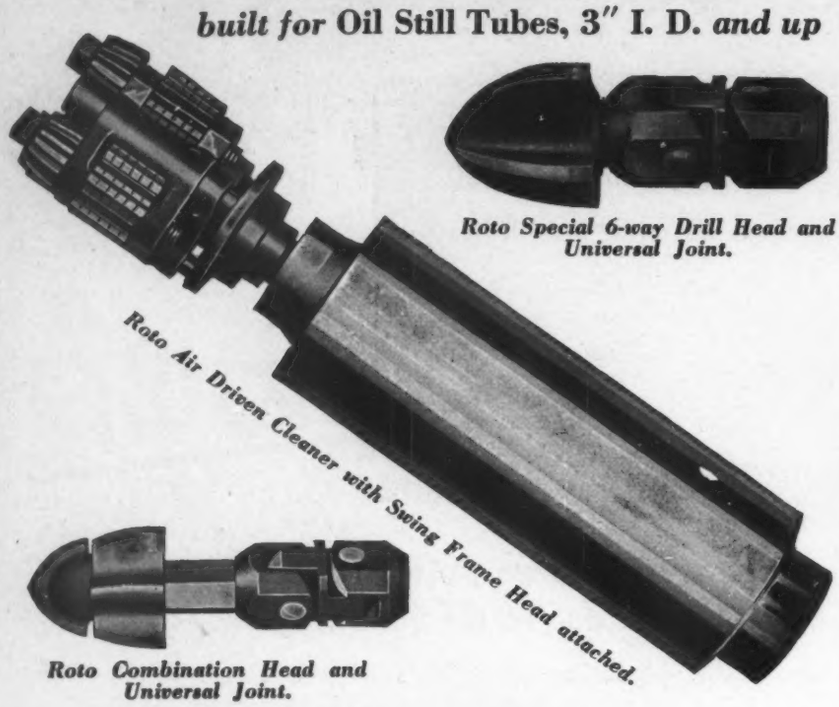

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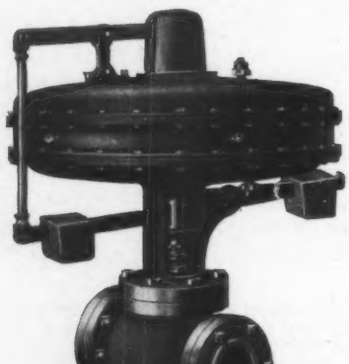

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The articles comprise a carefully prepared summary of the latest views on the structure of asphalt. Colloid chemistry is discussed in relationship to the colloid chemistry of asphalt. The classification of the component substances of asphalt is discussed along with modern views on asphalt structure. Properties of asphalts are discussed in relation to composition.

The Determination of Asphalt and Solid Foreign Matter in Oils. K. O. MULLER. *Erdol and Teer* **8** (1932) pp. 235-7.

The author gives a detailed description of the apparatus and method of Woog and Giraudon for the determination of asphalt and solid matter in oils. Comparative results are included that show the superiority of this method over others. The method is also recommended for use in analytical determinations in which fine inorganic or organic precipitates are produced.

The Measurement of the Viscosity of Tar. GUY BARR AND A. L. THORGOOD. *Chem. and Industry,* **51** (1932) pp. 381T-92T.

A study of the possible errors in the construction of the Hutchinson tar tester was made using various counterpoised solids having exaggerated errors in shape and size. The times of descent were observed in six for samples of different types. The rate of fall was found to be almost directly proportional to the net apparent weight, as required by a simple formula developed on the assumption that the resistance to motion is due solely to viscous forces acting in a normal liquid. The absolute viscosities of the tars were determined by the falling sphere method using X-rays to follow the fall. The apparent viscosity of the unstirred samples varied with thermal history. The conversion factors deduced for the relation between absolute viscosity, Hutchinson time T_h, and B.R.T.A. time T_r (Redwood) are put forward with some reserve.

Detection of Pitch and Tar in Asphalt, Bitumens, and Protective Coatings. P. MECKE. *Teer u. Bitumen* **30** (1932) pp. 284-7.

The addition of a few drops of a solution of p-nitrobenzene diazonium sulfate to an acidified caustic extract of the material to be tested causes a deep red coloration if the material contains 1% or more of tar or pitch. Again, pure asphalt or bitumens, when warmed with sulfuric or phosphoric acid impart a bright brown color to the solution. The presence of 10% of pitch or 1% of tar gives the solution a dark brown or muddy color. On cooking down through a solution of the material in ethylsulfuric acid show a layer of chloroform, and against a dark background, a sky-blue color is observed if tar or pitch is present. The presence of tar or pitch is also indicated if a green color is seen when the solution is held before a cobalt glass lantern in a dark room. This test is sensitive to 0.5% pitch and 0.25% tar.

Natural Gasoline

Commercial Butane as a Ceramic Fuel. C. F. GREENE. *J. Am. Ceram. Soc.* **15** (1932) pp. 495-500.

Plant-scale tests show that butane, as compared to coal-gas, gives 5% higher thermal efficiency, 10°F. higher preheater temperature, a longer flame, and, in the operation of a McDougal funnel kiln, a saving of 31% in fuel cost.

THE MONTH IN REVIEW

Refinery Committees For 1933 Are Named

PERSONNEL of the American Petroleum Institute Committees on Corrosion of Refinery Equipment and on Accident Prevention in Refineries has been announced by Walter Miller, Continental Oil Company, Ponca City, Oklahoma, chairman of the Central Committee on Refinery Technology of the Division of Refining. R. P. Anderson of the institute staff is secretary of the central committee, and the secretaries of the two subordinate committees likewise are members of the staff. D. V. Stroop, engineer, is secretary of the Committee on Corrosion of Refinery Equipment, and Walter Samans, The Atlantic Refining Company, Philadelphia, is chairman. H. N. Blakeslee, director of the Institute Department of Safety, with headquarters at Dallas, is secretary of the Committee on Accident Prevention in Refineries, and C. W. Smith, Standard Oil Company (Indiana), Chicago, is the chairman.

Membership on the two committees is as follows: Committee on Corrosion of Refinery Equipment:

F. C. Braun, Gulf Refining Company, Pittsburgh; E. S. Dixon, The Texas Company, Port Arthur; J. W. Griswold, Crew-Levick Company, Philadelphia; A. E. Harnsberger, The Pure Oil Company, Chicago; C. H. Haupt, Standard Oil Development Company, Elizabeth, New Jersey; K. V. King, Standard Oil Company of California, San Francisco; L. G. Metcalf, Union Oil Company, Los Angeles; N. B. Musser, Sun Oil Company, Marcus Hook; J. W. Newton, Magnolia Petroleum Company, Beaumont, Texas; C. J. Nobmann, Shell Oil Company, San Francisco; L. W. Parsons, Tide Water Oil Company, Bayonne; S. S. Shaffer, Humble Oil & Refining Company, Baytown, Texas; Thos. D. Tifft, Sinclair Refining Company, New York; and W. G. Whitman, Standard Oil Company (Indiana), Whiting, Indiana.

Committee on Accident Prevention in Refineries:

C. P. Anderson, Richfield Oil Company, Los Angeles; J. C. Bernd, Sinclair Refining Company, East Chicago; R. W. Black, Standard Oil Company, New Jersey, Elizabeth, New Jersey; J. S. Boylan, Continental Oil Company, Ponca City; J. H. Brown, Tide Water Oil Company, New York; C. W. Coleman, Gulf Refining Company, Port Arthur; V. R. Currie, The Texas Company, New York; R. E. Donovan, Standard Oil Company of California, San Francisco; J. H. Herbert, Standard Oil Company of Ohio, Cleveland; W. C. Lynch, General Petroleum Corporation, Los Angeles; S. H. McKenty, The Atlantic Refining Company, Philadelphia; Ray E. Miller, Natural Gasoline Association of America, Tulsa; C. J. Nobmann, Shell Oil Company, San Francisco; A. A. Odell, Barnsdall Refineries, Inc., Tulsa; G. F. Prussing, Union Oil Company, Los Angeles; W. P. Reymond, Jr., Standard Oil Company of Louisiana, Baton Rouge; and C. L. Swim, Skelly Oil Company, Tulsa.

Refinery "Makes the Movies"

PETROLEUM Refining and motion pictures mix in "State Trooper" and the accompanying photograph taken in the fire control house of Standard Oil Company of California, El Segundo refinery is some of the evidence.

Evalyn Knapp and Regis Toomey, others in the cast and the usual directors, members of the sound and camera department spent many days at the El Segundo plant when Standard Oil Company permitted Columbia Pictures to film State Trooper at the plant. The energetic publicity department of Columbia Pictures submitted many photographs and much information and the above picture of a control room out of control and a speed cop with an empty pistol (perhaps he had to empty it at Evalyn to get her to pose as is) was selected to make our readers want to visit the El Segundo plant where these things might happen again. The publicity director for the picture concern remarks that State Trooper is going to show the motor owning moving picture fan that it requires a long and intricate process to provide him his daily needs.

In the fire control room at El Segundo

Natural Gasoline Association Meeting

THE Natural Gasoline Association of America will hold its annual meeting at Hotel Mayo, Tulsa, Oklahoma, May 15, 16 and 17, thus ending its final session on the day of the first session of the semi-annual convention of the American Petroleum Institute starting May 17. The gasoline association program committee consists of E. L. Peck, Empire Oil & Refining Company, chairman; F. E. Rice, Phillips Petroleum Company; G. M. Campbell, United Public Service Company and R. C. Wheeler, General Petroleum Corporation. This group is now assembling papers to be presented at the association meeting.

Deviation of Natural Gas From Boyle's Law

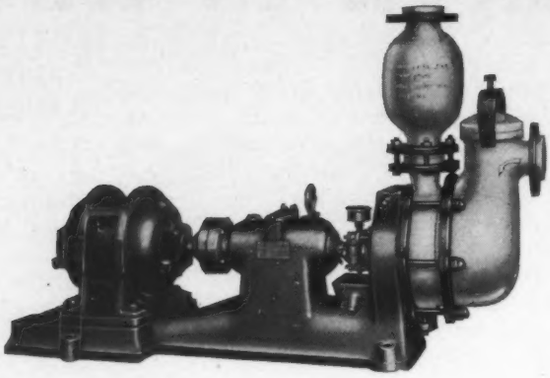
THE relationship as expressed by Boyle's Law, that at constant temperatures the volume occupied by a gas is inversely proportional to the absolute pressure is not strictly applicable to natural gas, according to the Bureau of Mines in Technical Paper 539 (Superintendent of Documents, Government Printing Office, Washington, price five cents). The amount of deviation from the law depends upon the temperature, pressure and chemical composition of the gas. This investigation was confined to natural gas under pressures up to 1000 pounds per square inch and at temperatures ranging from 40 to 80°F. The report contains a detailed description of apparatus used and the laboratory procedure, with an analysis of results and a discussion of the application of this deviation to gas engineering problems, such as measurement of natural gas and estimation of gas reserves and the like.

Standard Abbreviations for Science and Engineering

FREQUENT misunderstandings among scientists and engineers because of a confusion of different abbreviations for technical terms used in their writing have led to the establishment, under the auspices of the American Standards Association, of a tentative national standard for abbreviations for the most common scientific and engineering terms.

The standard, covering abbreviations ranging all the way from acres to kilovolt amperes, has just been published by the American Society of Mechanical

Duriron Self-Priming Centrifugal Pump No. 50



If An Acid Tank Car

Should Let Go . . . !

There is a real hazard in unloading acid tank cars with compressed air. Tank cars have been known to burst under air pressure, causing fatal accidents. Acid burns and other accidents are not uncommon when this dangerous method is employed.

The practical, safe way is to use a Duriron self-priming centrifugal pump. Owing to the universal resistance of Duriron to acids and abrasives, this pump can be employed for any strength sulphuric acid.

Duriron centrifugal pumps are made in sizes from 2″ x 1½″ suction and discharge to 10″ x 8″ suction and discharge. They are indispensable equipment for the modern refinery. Furnished for either belt or direct motor drive.

Our engineers are specialists in meeting corrosion problems . . . and they are at your service.

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Makers of Duriron and Durimet Acid-Proof Valves

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with heat from the flue gases

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CONTINUOUS REGENERATIVE COUNTERFLOW

Engineers, 29 West 39th Street, New York, one of the five national engineering and scientific organizations which are taking the leadership through the agency of the American Standards Association in the preparation of a long series of national standards for technical symbols as well as abbreviations for all branches of science and engineering. The other four organizations are the American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Society of Civil Engineers, and the Association for the Promotion of Engineering Education. Price of the bulletin is 40 cents.

Pennsylvania Refiners Form Research Corporation

IN order to secure, protect and develop patents pertaining to the improvement of products from Pennsylvania crude oil, the Pennsylvania Grade Crude Oil Association has formed the Pennsylvania Petroleum Research Corporation. This development is in connection with the research work being conducted by the association at Pennsylvania State College. Ralph T. Zook, president of the association, was elected president of the new corporation, and John Beck, vice president.

Fayette B. Dow was appointed vice president and general counsel of the new organization. Samuel Messer was named treasurer and T. O. Grissell, secretary. Directors include Forrest D. Dorn, E. C. Breene, Harry A. Logan, David B. McCalmont, C. L. Suhr and Dean F. C. Whitmore of Pennsylvania State College.

Research in refined products at State College is financed by the association and the new research corporation will protect the developments resulting from the work there. The corporation is a non-profit organization and any money derived from patent and process development will be returned to the general research fund to carry on further research.

Howard Coonley Heads American Standards Assn.

THE election of Howard Coonley, president of Walworth Company, New York, to the presidency of the American Standards Association for the year 1933 was announced January 9. Election of Mr. Coonley, who is also a director of several industrial, insurance, and banking organizations, to head the national standardization work in which over 570 organizations and 2700 individuals are engaged, follows several years of active connection with the standardization movement as the

Crack or Bust

"Many of the 145 companies operating refineries without cracking facilities realize that they cannot much longer market straight-run solely and must crack and perhaps engage in some naphtha reforming."—GEORGE REID *in Refiner and Natural Gasoline Manufacturer.*

Just ordinary cracking won't solve the refiner's problem but Dubbs cracking will

Dubbs cracking makes the highest yield of the best anti-knock gasoline from any charging stock at lowest cost—royalty and all And you are safe from patent litigation Your profits won't be taken away from you

Dubbs cracking always pays

Universal Oil Products Co
Chicago, Illinois

Dubbs Cracking Process
Owner and Licensor

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. . make VULCAN SUPERIOR the Tongs for Refinery Work

Seven Sizes with either Flat Link or Cable Chain for pipe and fittings 1/8" to 12"

In this latest addition to Williams' line of Superior Chain Pipe Tools, will be found the ideal Tongs for refinery work. "Vulcan Superior" is equally efficient on *pipe* or *fittings*. No parts to change, no adjustments — switch from one to the other instantly.

"Vulcan Superior's" unusual jaw design provides a greater number of "bites", assuring positive grip and reducing wear on the teeth. The reversible feature of these jaws also gives the tool double life. Each Flat Link Chain is proof-tested and *certified*.

Williams' "Vulcan Superior" Tongs embody every good feature of earlier designs *plus* many new improvements. Without question it is the best Chain Pipe Tong that has *ever* been offered pipe workers.

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VULCAN SUPERIOR
PIPE AND FITTINGS TONGS

representative of the American Society of Mechanical Engineers and the mechanical industries. Mr. Coonley succeeds Bancroft Gherardi, vice president of American Telephone and Telegraph Company, as president of the American Standards Association.

The election of F. E. Moskovics, chairman of the board of directors of the Marmon-Herrington Company, Indianapolis, to the vice presidency of the association was also announced. Mr. Moskovics, who was formerly vice president of Franklin Automobile Company and president of Stutz Motor Car Company, has represented the Society of Automotive Engineers in national standardization work for some time.

▼ PLANT ACTIVITIES ▼

Abandoned: Union Pacific Gasoline Company, Long Beach, Champion Gasoline Company, Hynes, Cherry Oil Company, Long Beach, Petroleum Specialties Company, Los Angeles, (Bandini), Rotary Process Company, Fruitvale, Sante Fe Springs Refining Company, Sante Fe Springs, Torrance Refining Company, Torrence, and two other idle California refineries, have been purchased by Attorney John Beemer, Los Angeles, representing unknown parties, and the plants are being abandoned or dismantled.

Operating: Dickie Oil Company has completed construction of its McPherson, Kansas, refinery and has been making test runs on the plant. Designed by company engineers and not by Winkler-Koch Engineering Company as was erroneously reported last month.

Refinery: Ball Oil Corporation, producers in Joiner area of East Texas field erecting 400-barrel skimming plant, D. M. Bradford lease, near Henderson-Overton highway.

Refinery: Gilliland Refining Company, headquarters Gladewater, Texas, organized in January by John W. Gilliland, P. Middleton and Mike Lyles, building a 1,000-barrel skimming plant, western side of Gladewater, East Texas field. O. H. Berryman, plant superintendent.

Expansion: Standard Oil Company of New Jersey, through its subsidiary Pan American Foreign Corporation, is installing additional tankage and crude oil distilling units at the Aruba, D. W. I. refinery preparing to handle more Venezuelan crude oil.

Refinery: White Star Refining Company, Cisco, Texas, E. M. Corah, vice president and general manager, plans erection of 1,000-barrel refinery at Hamlin, Jones County, Texas, to process Fisher County crude on contract with Southern Oil Corporation, Fort Worth. (Not to be confused with Vacuum Oil Company subsidiary of same name operating refinery at Trenton, Michigan).

Refinery: Southern Crude Oil Refining Company, headed by Phillip J. Stapp, New York, has announced plans to build a small refinery in the new Miller County, Arkansas, field.

Refinery: Joe Burnham et al have announced plans to build a 1,000-barrel skimming plant on the Ben F. Smith lease, Miller County, Arkansas field, Garland City-Texarkana highway. W. S. Avery, plant manager.

Refinery: C. C. Yeager of Gladewater, Texas, secured 10-acre site at McKinney Switch, 15 miles east of Texarkana, Arkansas, for construction of 1,000 skimming plant to refine Miller County crude.

Tank Car Sale: The Pure Oil Company reported as selling 2,100 tank cars and its car repair shops at Ardmore and Muskogee to Union Tank Car Corporation, which concern is reported to have purchased about 200 tank cars from Continental Oil Company.

Cracking: Ohio Oil Company through negotiations with Gasoline Products Company had its license broadened to permit installation and operation of de Florez, Cross, Tube and Tank, and combination units in addition to Holmes-Manley process which it was already operating at Lincoln Oil & Refining Company's plant at Robinson, Illinois. Ohio will erect two 1,500-barrel units at once, at Fort Worth, Texas, and Bristow, Oklahoma, refineries of Marathon Oil Company. Contract to M. W. Kellogg Company. (Refiner, Jan. 1933, page 38a).

Cracking: Continental Oil Company, Glenrock, Wyoming, to install cracking facilities, construction by M. W. Kellogg Company, according to reports, replacing Burton stills.

Skimming Plant: Wyoming Oils, Inc., building 100-barrel plant at Mills, a suburb of Casper, Wyoming. In same locality, Paul Huber interests are building 125-barrel plant east of Casper on Yellowstone Highway.

Gasoline Plant: Crosbie & Moran, Inc., moving Earlsboro gasoline plant equipment to West Holdenville Pool, Hughes County, Oklahoma, capacity 35,000,000 feet daily, well pressure operation.

Gasoline Plant: Montana Power Company has completed natural gasoline plant near Cut Bank, Montana, processing gas from the Cut Bank field. Campbell type installation. (Refiner, Nov. 1932, page 58A).

Cracking: Mexican Petroleum Company (subsidiary of Pan American Petroleum and Transport Company, Standard Oil Company of Indiana, at its Baltimore, Maryland, asphalt plant, will install new topping facilities, new cracking equipment and pump house, treating plant, stabilization system and other auxiliaries. Announced cost $500,000.

Refinery: Chas. Knox, Enid, Oklahoma, reported planning erection of new refining equipment at estimated cost of $250,000.

Refinery: Hi-Way Oil Company, Vancouver, B. C., Canada, is erecting new refinery on recently acquired site at Vancouver.

Cracking: Argentine Government, Buenos Aires, Argentina, South America, awarded contract for construction of new cracking equipment for La Plata refinery to M. W. Kellogg Company, reported cost, $600,000. Owners will spend $400,000 additional on reconstruction and modernization of existing cracking units at the refinery.

Distillation Unit: Bradford Oil Refining Company, Bradford, Pa., erecting new distillation unit for preparation of lubricants. Contract to Leader Industries, Inc., capacity 1,500 barrels daily.

Improvement: Shell Petroleum Corporation at Houston, Texas, enlarging stabilization system and at East Chicago, Indiana, plant reports state a $600,000 improvement program is underway.

Operating: Globe Oil & Refining Company reports plans to begin operating its new refinery at McPherson, Kansas, about February 15.

To Resume: Middlesex Refining Company, New York, City, is reported planning to reopen refinery at New Brunswick, New Jersey, and to remodel and modernize.

Stabilizer: Wasatch Oil Refining Company, Woods Cross, Utah, near Salt Lake City, plans erection of new gasoline recovery and stabilization facilities.

Cracking: The Caminol Company, Ltd., Los Angeles, planning erection of cracking facilities at Sante Fe Springs refinery.

Refinery: R. J. and M. H. McMurray, building 1,000-barrel skimming plant three miles north of Arp, Smith County, East Texas, field.

Refinery: Dutch Rose Refining Company, (Frank Traweek and associates) building 200-barrel skimming plant, Gladewater, East Texas field.

Enlarging: Hancock Oil Company, at Long Beach, California, refinery is enlarging capacity from 12,000 to 15,000 barrels per day. Contract to Southwestern Engineering Corporation.

Gasoline Plant: Ramsey Petroleum Corporation operating on Buckingham-New Raymer structure, Weld County, Colorado, reported planning installation of natural gasoline plant.

Asphalt Plant: W. E. Willis and associates are erecting a 250-barrel asphalt unit in East Jackson, Mississippi, to operate on Jackson heavy crude, marketing asphalt to the highway department of Mississippi.

Improvements: Bell Oil & Gas Company at Grandfield, Oklahoma, refinery is rebuilding and modernizing Dubbs cracking unit, to increase capacity from 1,000 to 1,700 barrels, also adding new treating equipment and tankage. Reported cost $100,000.

Enlarging: Rex Refining Company, Rapid City, South Dakota, operating on Osage, Wyoming, crude, is increasing capacity from 150 to 300 barrels per day.

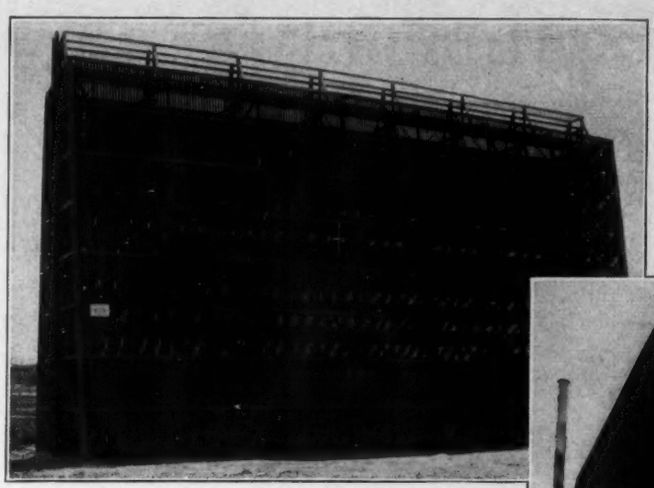
Refinery: The Texas Company and Socony-Vacuum Corporation are reported studying the advisability of recting a jointly owned refinery in Argentina, South America.

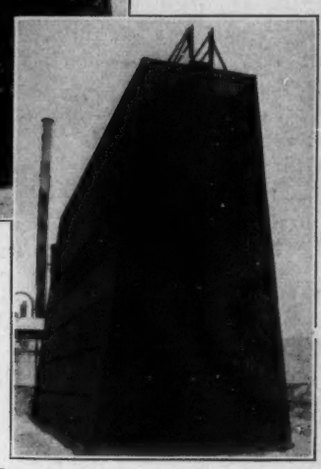
Gasoline Line: The Globe Oil & Refining Company is reported planning construction of 140-mile gasoline pipe line from its refinery at McPherson, Kansas to Superior, Nebraska.

Distillation Unit: W. H. Daugherty & Son Refining Company, Petrolia, Pennsylvania, contract to Arthur G. McKee & Company, erecting 2,000-barrel vacuum distillation unit.

Distillation Unit: Pure Penn Refining Company, Clarendon, Pennsylvania, nearing completion of new pipe still distillation unit, contract, Arthur G. McKee & Company.

Merger: Champlain Oil Products, Ltd., is newly organized controlling company following merger of LaSalle Petroleum Corporation, Ltd., (Joseph Elie, Ltd., with refinery at East Montreal, Canada), Loyal Oil & Gas Company, Ltd., Sylvester Oil, Ltd. Automobile Owners Association, and Exchange Petroleum, Ltd. Harry Snyder and associates control the group to operate as Champlain Oil Products, Ltd.





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A NEW design in spray deck cooling towers—built on extremely graceful lines and engineered for maximum efficiency and economy.

The wide base provides sound bracing to resist high winds. The simplified louvre system admits more air. Downspray nozzle arrangement distributes water evenly on the decks and leaves nozzles easily accessible for cleaning. Tapered decks keep water on the decks at all times and prevent slopping down against the louvres.

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New Equipment for the Modern Plant

1. Protective Hats and Caps

MINE SAFETY APPLIANCES CO.

Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh, Pennsylvania, announces a line of skull protection headgear for use in refineries and other places where concussion of the brain is apt to result from explosions or from falling objects. The "Skullgards" are available in three styles for those who are particular about the vogue of helmetry.

2. Slow Closing Loading Valve

A. Y. McDONALD MANUFACTURING COMPANY.

A. Y. McDonald Manufacturing Company, Dubuque, Iowa, announces a slow-self-closing loading line valve for which three advantages are claimed: full flow, slow closing, and easy opening.

McDonald Slo-Self-Closing Loading Line Valve

When the plunger moves toward closing position, liquid is drawn into a control chamber through a by-pass orifice. Speed of closing may be increased or decreased while the line is under pressure, if desired, for various operating pressures and viscosities of fluids handled, by removing the seal plug and turning the regulating screw to fit. According to the manufacturer, hydraulic control of the valve plunger eliminates excessive pressure and consequent hammering on the line.

Easy opening is accomplished by a parabolic cam located directly under the valve plunger. The cam is designed to give leverage on the hardened plunger roller the instant the valve starts to open.

3. Double Seal Ring

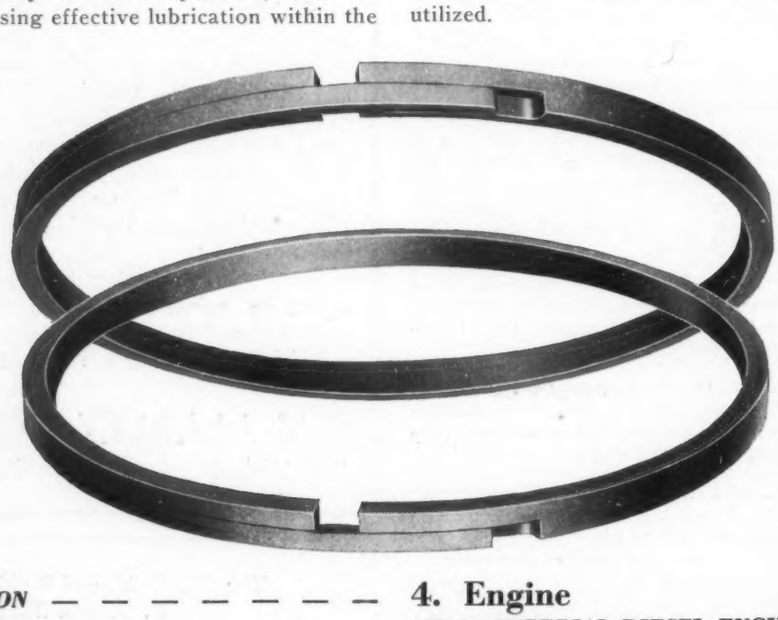
DOUBLE-SEAL RING COMPANY

Double-Seal Ring Company, Fort Worth, Texas, through its distributors in the oil industry, the Webster Engineering Company of Tulsa, announces a new one-piece double seal ring to meet the demand for an improved product to seal the gap against the cylinder wall and the ring groove.

This new one-piece ring has the same sealing effect as the two-piece double seal ring and is intended to prevent blow-by in worn cylinders, thus increasing effective lubrication within the walls of the cylinder and adding to the life of the equipment. In its new design the one-piece ring is generally similar to the two-piece double seal ring the company manufactures in that at the end of the gap and for some distance on each side of the gap the construction is identical retaining the same basic principle of sealing against leakage or double sealing both groove and wall. The same material is used in the one-piece ring as in the two-piece design.

According to the manufacturer, this new one-piece ring is an engineering advancement in the field of piston packing by bringing about improvement in combustion and with excessive wear in the cylinder walls to continue to hold compression after the joints have become enlarged due to wear on the face of the ring.

The new one-piece piston ring is adaptable for all kinds of oil industry usage, including Diesel and gas engines, compressor and pipe line engines and in pumping and drilling engines or where internal combustion power is utilized.



— — — — — — — — *MAIL COUPON* — — — — — — — —

REFINER AND NATURAL GASOLINE MANUFACTURER,
Houston, Texas, U. S. A.

Please see that I am supplied, without obligation, additional information on New Equipment Items Nos.....described in February, 1933, issue of REFINER.

Name .....

Company .....

Address .....

4. Engine

ATLAS IMPERIAL DIESEL ENGINE COMPANY

Atlas Imperial Diesel Engine Company, 115 Broad Street, New York, New York, announces production of a six-cylinder gasoline engine that operates on Diesel fuel oil, yet retains, according to the manufacturer, the speed, flexibility, acceleration, and light weight of the gasoline engine.

The transformation was accomplished by changing the cylinder head and addition of electrical injection and ignition systems of novel design.

5. Brine Treatment

D. W. HAERING & COMPANY

D. W. Haering & Company, 565 West Washington Street, Chicago, Illinois, has developed a highly efficient formula for controlling brine tank corrosion which utilizes colloidal glucosides to control electrolysis by buffer effect. The formula is adjusted to establish proper pH on initial treatment and the buffer action of the glucosides maintains this pH over extended periods without frequent additions of material. Oxygen is eliminated through direct chemical combination, a feature of all of the company's anti-corrosion products. H-O-H Brine Treatment is effective in salt or calcium chloride brine and is also a valuable agent for prevention and removal of lime and rust deposits from circulating brine systems.

Items About Manufacturers

Frick Company of Waynesboro, Pennsylvania, announces the appointment of the following distributors for the Frick line of refrigerating machinery: Oakland Ice Machine Company, 1622 E. 12th Street, Oakland, California; J. H. Lock & Sons. Ltd., 221 Sterling Road, Toronto, and 300 Youville Square, Montreal, Canada; Embrey Refrigerating Company, 127 N. W. 13 Street, Oklahoma City, Oklahoma; American Elevator and Machine Company, 500 E. Main Street, Louisville, Kentucky; Olchoff Engineering Company, 421 Dwight Building, Kansas City, Missouri; Davidson-Kennedy Company, 1090 Jefferson Street, N. W., Atlanta, Georgia; C. Kirk Hillman Company, 3201 First Avenue South, Seattle, Washington; Riechman-Crosby Company, 223 South Front Street, Memphis, Tennessee; Royal Cabinet & Manufacturing Company, 1311 Hayes Avenue, Salt Lake, City, Utah; Hayes Brothers, Incorporated, 236-38 West Vermont Street, Indianapolis, Indiana; Kent-Ervin Engineering Company, Builders Exchange Building, Minneapolis, Minnesota; E. L. Cole, Missoula, Montana; Evansville Supply Company, Second Ave. and Pennsylvania Street, Evansville Indiana; Meyer-Blanke Company, 410 Valentine Street, St. Louis, Missouri; Mechanical Equipment Corporation, Corner Howard Avenue and Carondelet Street, New Orleans, Louisiana; Ramon Pena, San Sebastian, Spain; and Elmac, Incorporated, Manila, P. I.

Shand and Jurs Sales Company, Denver, Colorado, announces appointment of M. P. Hare, 1003 Montreal Street, Dallas, Texas, as sales representative for that territory.

The Brown Instrument Company, Philadelphia, Pennsylvania, announces appointment of O. B. Wilson as district manager of the territory comprising Texas, Louisiana and Southern Arkansas. Mr. Brown, who formerly was manager of the Cleveland, Ohio, office of the company, in Houston.

The Babcock & Wilcox Tube Company, Beaver Falls, Pennsylvania, announces the opening of a district office in Tulsa, Oklahoma, at 2002 Philtower Building, under the direction of Carl J. Hochenauer.

The Babcock & Wilcox Tube Company, New York, New York, has appointed Fritz Hoving its West Coast district sales manager. Mr. Hoving will make his headquarters with A. M. Castle & Company at 2200-2300 East 55th Street, Los Angeles, California. For many years prior to his association with The Babcock & Wilcox Tubing Company, Mr. Hoving served Spang Chalfant and Company in a similar capacity.

Hills-McCanna Company announces opening of southern district offices in Houston, Texas, at 1309 Second National Bank Building, where A. P. Wright is in charge.

H. A. Paine, 1309 Second National Bank Building, Houston, Texas, has been made sales representative of Erie City Iron Works, Morris Machine Works, E. B. Badger & Sons Company, and Trilok Company.

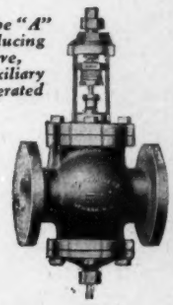
W. T. Alliger, Houston, Texas, representative for M. H. Deterick Company, DeLaval Steam Turbine Company, Cochrane Corporation, Automatic Cone Valve Company, and Schutte-Koerting Company, announces removal of his headquarters to 4421 Rusk Avenue.

The Babcock & Wilcox Company, New York, New York, announces appointment of E. A. Livingstone as sales representative with headquarters at 85 Liberty Street, New York, New York.

ATLAS
Regulating Valves for EVERY SERVICE

Whatever your refinery regulating problem may be, put it up to Atlas. The coupon at the right indicates our principal standard products, but not all of them. We also develop special regulating equipment. This is our 30th year.

Type "A" Reducing Valve, Auxiliary Operated

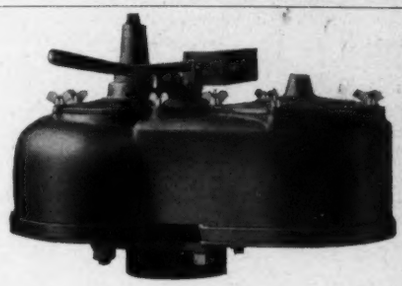


ATLAS VALVE CO.
275 South Street,
Newark, N. J.

ATLAS VALVE CO., 275 South St., Newark, N. J.
Without the slightest obligation, please send information, including prices, on the following Atlas products:
Name.....
Firm.....
Street.....
City.....
State.....

☐ Pump Governors	☐ Campbell Boiler Feed Water Regulator
☐ Float Valves	☐ Reducing Valves
☐ Swing Joint Fittings	☐ Damper Regulators
☐ Thermostats	☐ Temperature Regulators
☐ Balanced Valves	
☐ Control Valves	

S&J
ARMORED ALLCLIME BREATHER VALVE . . .



does the job better!

Exposure to the most extreme climatic conditions does not interfere with the operation of S & J Armored Allclime Breather Valves. Moving parts fully enclosed and protected. Dust, ice, rain or snow cannot interfere with pre-determined operating pressures. Neat appearance, light weight, easy to install and built to conform to the S & J high standard of quality. Pressure side of breather can be closed by drop-chain from ground, thereby permitting snuffing-out of flame in case of fire. The S & J Armored Allclime Breather Valve does the job better! Complete information on request.

We also manufacture liquid level controls, diaphragm valves, internal safety valves, gauging equipment, explosion vent reliefs, quick opening aluminum or bronze gate valves, fittings, winches, vapor recovery regulators, etc., for refinery requirements. Ask for Bulletins No. 50-A and 52.

SHAND AND JURS CO.
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NEW YORK - CLEVELAND - CHICAGO - MILWAUKEE - DENVER
S&J REG. U.S. PAT. OFF.
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Electrically Driven Centrifuges
Hand Centrifuges
WRITE
WILLIAMS, BROWN & EARLE, Inc.
Manufacturers of Laboratory Apparatus
918 Chestnut St. Philadelphia, Pa.

CATALOGS . . . BULLETINS

Helpful Publications Which Manufacturers Will Be Glad to Send Free for the Asking

Rotameters

Schutte & Koerting Company, Philadelphia, Pennsylvania, announce availability of Bulletin No. 6-F, describing a line of rotameters to show the flow rate of water, oil, air, gas, chemicals, and other fluids, liquid and gaseous. The rotameters are vertical and horizontal, low and high pressure.

Draft Gauges

The Hays Corporation, Michigan City, Indiana, announces availability of a bulletin describing a new line of dry type, portable draft gauges for heating engineers, fuel engineers, installers of oil and gas burners.

Package Filling

S. F. Bowser & Company, Fort Wayne, Indiana, has available a bulletin entitled "A Study of Barrel and Can Filling Problems." The chief purpose of the study is to enable any concern which packages its products in barrels or cans to compare obsolete or inefficient present methods with the most economical and efficient modern methods. It is also pointed out that the most modern method suggested can readily be used to fill any size container, whether it is a standard container or a "fill to full" package.

Pressure Vessel Charts

Henry Vogt Machine Company, Louisville, Kentucky, has available for distribution a detailed chart showing requirements of welded pressure vessels in classes 1, 2 and 3. This chart shows the summary of the entire range of tests on the three classes of vessels.

Gas Pumps

The Connersville Blower Company, Inc., Connersville, Indiana, announces publication of Bulletin 31-B11 which covers the Type "XA" and "XAS" gas pumps, developed for specialized service in those processes requiring complete separation of the gas or vapor handled, from the lubricant.

Wrenches

J. H. Williams & Co., Buffalo, New York, announces availability of a complete set of current loose leaf catalog pages in which list price revisions are shown on the "Supersocket" line and on the water pump patterns of "Superrenches", both single and double head.

Temperature Regulators

Sarco Company, Incorporated, 183 Madison Avenue, New York, New York, announces availability of Catalog 52, describing the complete line of Sarco temperature regulators.

Welding

Henry Vogt Machine Company, Louisville, Kentucky, announces availability of a four page, illustrated bulletin titled "Vogt Fusion Welding."

Turbines

General Electric Company, Schenectady, New York, announces publication of Bulletin GEA-957C, superseding GEA-957B, and describing in text, picture and diagram Type D-3 two and three stage turbines, 90 to 500 horsepower, designed to drive pumps, fans, compressors, pulverizers, and similar apparatus.

Rotary Displacement Pump

De Laval Steam Turbine Company, Trenton, New Jersey, announces publication of Catalog L-10 describing Series A 31 N, a rotary displacement pump, designed to run at standard speeds and at turbine speeds, which has only three moving parts, a power rotor and two idling rotors, the latter acting as seals to the power rotor, but driven principally by fluid pressure and requiring no pilot gears.

Instruments and Apparatus

American Instrument Company, 774 Girard Street, N. W., Washington, D. C., announces availability of four bulletins:

Bulletin 1220 describes a thermostatically controlled constant temperature bath, holding temperatures to 0.03° C. This bath is intended for all applications where very accurate temperature control over extended periods of time is desired.

Bulletin 1203 describes a portable temperature-control unit to convert any available container into an accurate constant-temperature bath.

Bulletin 1500 describes Lolag immersion heaters, both plain form and made up in easily applied units for tanks, stills, etc., for all applications where liquids are to be heated electrically.

Bulletin 1520 gives a complete line of laboratory heating apparatus, including hot plates, rheostat heaters, flask heaters, muffle furnaces, crucible furnaces and tube furnaces.

Steam Traps

Armstrong Machine Works, Three Rivers, Michigan, announces availability of a new manual on steam trap engineering and containing complete information on the inverted bucket steam traps. Important chapters in the book include the following: Tables giving the actual dollars cost of various sized steam leaks and the effect of entrained air on heating temperatures; How to determine size of trap required for medium, high, or fluctuating pressures and extra large volumes of condensates; How to calculate the rate of condensation in the various types of equipment where steam is used; Condensate drainage systems; and installation and maintenance of traps.

Radial Piston Pumps and Motors

Northern Pump Company, Minneapolis, Minnesota, announces availability of Bulletin No. 5000, describing Series 5000 line of hydraulic pumps and motors of the rotary radial piston type, ranging in capacities from one to 200 gallons per minute and designed for pressures up to 4000 pounds per square inch.

Steam Pumps

Worthington Pump and Machinery Corporation, Worthington Avenue at Warren Street, Harrison, New Jersey, recently released the following list of new catalogs and bulletins on direct acting steam pumps, horizontal duplex piston type:

Bulletin W-101-S1, for general services; capacities from 35 to 320 gallons per minute.

Bulletin W-101-S2, for handling oils up to 350°F., capacities from 60 to 315 gallons per minute.

Bulletin W-101-S3, for general services; capacities from 6 to 230 gallons per minute.

Bulletin W-101-S4, for handling oils up 350°F., capacities from 31 to 240 gallons per minute.

Bulletin W-101-S5, for handling oils up to 650°F., capacities from 54 to 235 gallons per minute.

Bulletin W-101-S6, for handling oils up to 650°F., capacities from 26 to 160 gallons per minute.

Bulletin W-101-S7, for condensate return service, supplied with automatic receiver, capacities from 14 to 34 gallons per minute.

Bulletin W-102-S1 and supplement, Turret type for general service, capacities from 34 to 725 gallons per minute.

Bulletin W-102-S2 and supplement, for general services, capacities from 175 to 345 gallons per minute.

Bulletin W-103-S1 and supplement, Pot valve style for handling oils up to 350°F., capacities from 50 to 330 gallons per minute.

Bulletin W-103-S2 and supplement, handling oils up to 700°F., capacities from 66 to 240 gallons per minute.

Bulletin W-103-S3 and supplement, Pot valve style for general services, capacities from 56 to 98 gallons per minute.

Bulletin W-103-S4 and supplement, Pot valve, outside end packed plungers, for boiler feed and pressure service, capacities 26 to 800 gallons per minute.

Bulletin W-103-S5, Pot valve, for handling oils up to 350°F., capacities from 195 to 1795 gallons per minute.

Bulletin W-103-S6, Pot valve, for handling oils up to 700°F., capacities from 210 to 720 gallons per minute.

Horizontal simplex double plunger forged cylinder hydraulic pumps. Bulletin D-111-S1A, maximum liquid end pressure 10,000 pounds.

USE THIS COUPON
(Address manufacturer direct)

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Please send to me, without obligation, free booklet described in the February, 1933, issue of REFINER AND NATURAL GASOLINE MANUFACTURER.

NAME .....

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